

# Webb County Main Fire Station And Administration Building

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FOR

## WEBB COUNTY



*M. A. Pena*

Architect's Project #: 1312

Date Issued: 11/14/14

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# SPECIFICATIONS

## VOLUME 1 OF 2

Owner:  
Webb County  
1620 Santa Ursula, 2nd Floor  
Laredo, Tx 78040  
956-523-4055  
Contact: Luis Perez Garcia Iii, Pe., C.F.M.

ARCHITECT:  
Hickey Peña Architects  
919 Victoria  
Laredo, TX 78040  
956.722.8186  
Contact: Mario A Peña

Civil Engineer:  
Peua Consulting L.L.C.  
109 E Del Mar Blvd #5  
Laredo, Tx 78041  
210-621-5797  
Contact: Oscar Castillo P.E.

Structural Engineer:  
Synergy Structural Engineering, Inc.  
6909 Springfield Ave. Suite: 105  
Laredo, Tx 78041  
956-753-5860  
Contact: Victor De Anda

Mep:  
Nrg Engineering  
5656 S Staples, Suite 360  
Corpus Christi, Tx 78411  
361-852-2727  
Contact: John Rodriguez

## **VOLUME 1**

PROPOSALS & CONSTRUCTION REQUIREMENTS  
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## **VOLUME 2**

DIVISION 15 MECHANICAL  
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## **SECTION 15050**

### **BASIC MATERIALS AND METHODS**

#### **PART 1 - GENERAL**

##### **1.01 GENERAL REQUIREMENTS**

- A. The requirements of the General Conditions and Supplementary Conditions apply to all Work herein.
- B. The Contract Drawings indicate the extent and general arrangement of the systems. If any departure from the Contract Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore, shall be submitted to the Architect for approval as soon as practicable. No such departures shall be made without the prior written approval of the Architect.
- C. Notwithstanding any reference in the Specifications to any article, device, product, material, fixture, form or type of construction by name, make or catalog number, such reference shall not be construed as limiting competition; and the Contractor, in such cases, may at his option use any article, device, product, material, fixture, form or type of construction which in the judgment of the Architect, expressed in writing, is equal to that specified.

##### **1.02 SCOPE OF WORK**

- A. The Work included under this Contract consists of the furnishing and installation of all equipment and material necessary and required to form the complete and functioning systems in all of its various phases, all as shown on the accompanying Drawings and/or described in these Specifications. The contractor shall review all pertinent drawings, including those of other contracts prior to commencement of Work.
- B. This Division requires the furnishing and installing of all items Specified herein, indicated on the Drawings or reasonably inferred as necessary for safe and proper operation; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, transportation, storage, equipment, utilities, all required permits, licenses and inspections. All work performed under this Section shall be in accordance with the Project Manual, Drawings and Specifications and is subject to the terms and conditions of the Contract.
- C. The approximate locations of Mechanical (HVAC) and Plumbing items are indicated on the Drawings. These Drawings are not intended to give complete and accurate details in regard to location of outlets, apparatus, etc. Exact locations are to be determined by actual measurements at the building, and will in all cases be subject to the Review of the Owner or Engineer, who reserves the right to make any reasonable changes in the locations indicated without additional cost to the Owner.
- D. Items specifically mentioned in the Specifications but not shown on the Drawings and/or items shown on Drawings but not specifically mentioned in the Specifications shall be installed by the Contractor under the appropriate section of work as if they were both specified and shown.
- E. All discrepancies between the Contract Documents and actual job-site conditions shall be reported to the Owner or Engineer so that they will be resolved prior to the bidding, where this cannot be done at least 7 working days prior to bid; the greater or more costly of the

discrepancy shall be bid. All labor and materials required to perform the work described shall be included as part of this Contract.

- F. It is the intention of this Section of the Specifications to outline minimum requirements to furnish the Owner with a turn-key and fully operating system in cooperation with other trades.
- G. It is the intent of the above "Scope" to give the Contractor a general outline of the extent of the Work involved; however, it is not intended to include each and every item required for the Work. Anything omitted from the "Scope" but shown on the Drawings, or specified later, or necessary for a complete and functioning heating, ventilating and air conditioning system shall be considered a part of the overall "Scope".
- H. The Contractor shall rough-in fixtures and equipment furnished by others from rough-in and placement drawings furnished by others. The Contractor shall make final connection to fixtures and equipment furnished by others.

#### 1.03 SCHEMATIC NATURE OF CONTRACT DOCUMENTS

- A. The contract documents are schematic in nature in that they are only to establish scope and a minimum level of quality. They are not to be used as actual working construction drawings. The actual working construction drawings shall be the approved shop drawings.
- B. All duct or pipe or equipment locations as indicated on the documents do not indicate every transition, offset, or exact location. All transitions, offsets clearances and exact locations shall be established by actual field measurements, coordination with the structural, architectural and reflected ceiling plans, and other trades. Submit shop drawings for approval.
- C. All transitions, offsets and relocations as required by actual field conditions shall be performed by the contractor at no additional cost to the owner.
- D. Additional coordination with electrical contractor may be required to allow adequate clearances of electrical equipment, fixtures and associated appurtenances. Contractor to notify Architect and Engineer of unresolved clearances, conflicts or equipment locations.

#### 1.04 SITE VISIT AND FAMILIARIZATION

- A. Before submitting a bid, it will be necessary for each Contractor whose work is involved to visit the site and ascertain for himself the conditions to be met therein in installing his work and make due provision for same in his bid. It will be assumed that this Contractor in submitting his bid has visited the premises and that his bid covers all work necessary to properly install the equipment shown. Failure on the part of the Contractor to comply with this requirement shall not be considered justification for the omission or faulty installation of any work covered by these Specifications and Drawings.
- B. Understand the existing utilities from which services will be supplied; verify locations of utility services, and determine requirements for connections.
- C. Determine in advance that equipment and materials proposed for installation fit into the confines indicated.

1.05 WORK SPECIFIED IN OTHER SECTIONS

- A. Finish painting is specified. Prime and protective painting are included in the work of this Division.
- B. Owner and General Contractor furnished equipment shall be properly connected to Mechanical (HVAC) and Plumbing systems.
- C. Furnishing and installing all required Mechanical (HVAC) and Plumbing equipment control relays and electrical interlock devices, conduit, wire and J-boxes are included in the Work of this Division.

1.06 PERMITS, TESTS, INSPECTIONS

- A. Arrange and pay for all permits, fees, tests, and all inspections as required by governmental authorities.

1.07 DATE OF FINAL ACCEPTANCE

- A. The date of final acceptance shall be the date of owner occupancy, or the date all punch list items have been completed or final payment has been received. Refer to Division One for additional requirements.
- B. The date of final acceptance shall be documented in writing and signed by the architect, owner and contractor.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- B. Deliver products to the project at such time as the project is ready to receive the equipment, pipe or duct properly protected from incidental damage and weather damage.
- C. Damaged equipment, duct or pipe shall be promptly removed from the site and new, undamaged equipment, pipe and duct shall be installed in its place promptly with no additional charge to the Owner.

1.09 NOISE AND VIBRATION

- A. The heating, ventilating and air conditioning systems, and the component parts thereof, shall be guaranteed to operate without objectionable noise and vibration.
- B. Provide foundations, supports and isolators as specified or indicated, properly adjusted to prevent transmission of vibration to the Building structure, piping and other items.
- C. Carefully fabricate ductwork and fittings with smooth interior finish to prevent turbulence and generation or regeneration of noise.
- D. All equipment shall be selected to operate with minimum of noise and vibration. If, in the opinion of the Architect, objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of the Work, the Contractor shall rectify such conditions without extra cost to the Owner.

#### 1.10 APPLICABLE CODES

- A. Obtain all required permits and inspections for all work required by the Contract Documents and pay all required fees in connection thereof.
- B. Arrange with the serving utility companies for the connection of all required utilities and pay all charges, meter charges, connection fees and inspection fees, if required.
- C. Comply with all applicable codes, specifications, local ordinances, industry standards, utility company regulations and the applicable requirements of the following nationally accepted codes and standards:
  - 1. Air Moving & Conditioning Association, AMCA.
  - 2. American Standards Association, ASA.
  - 3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., ASHRAE.
  - 4. American Society of Mechanical Engineers, ASME.
  - 5. American Society of Plumbing Engineers, ASPE.
  - 6. American Society of Testing Materials, ASTM.
  - 7. American Water Works Association, AWWA.
  - 8. National Bureau of Standards, NBS.
  - 9. National Fire Protection Association, NFPA.
  - 10. Sheet Metal & Air Conditioning Contractors' National Association, SMACNA.
  - 11. Underwriters' Laboratories, Inc., UL.
  - 12. International Energy Conservation Code, IECC.
- D. Where differences existing between the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, the more stringent or costly application shall govern. Promptly notify the Engineer in writing of all differences.
- E. When directed in writing by the Engineer, remove all work installed that does not comply with the Contract Documents and applicable state or city building codes, state and local ordinances, industry standards, utility company regulations and the applicable requirements of the above listed nationally accepted codes and standards, correct the deficiencies, and complete the work at no additional cost to the Owner.

#### 1.11 DEFINITIONS AND SYMBOLS

- A. General Explanation: A substantial amount of construction and Specification language constitutes definitions for terms found in other Contract Documents, including Drawings which must be recognized as diagrammatic and schematic in nature and not completely descriptive of requirements indicated thereon. Certain terms used in Contract Documents are defined generally in this article, unless defined otherwise in Division 1.
- B. Definitions and explanations of this Section are not necessarily either complete or exclusive, but are general for work to the extent not stated more explicitly in another provision of the Contract Documents.
- C. Indicated: The term "Indicated" is a cross-reference to details, notes or schedules on the Drawings, to other paragraphs or schedules in the Specifications and to similar means of recording requirements in Contract Documents. Where such terms as "Shown", "Noted", "Scheduled", "Specified" and "Detailed" are used in lieu of "Indicated", it is for the purpose of helping the reader locate cross-reference material, and no limitation of location is intended except as specifically shown.

- D. Directed: Where not otherwise explained, terms such as "Directed", "Requested", "Accepted", and "Permitted" mean by the Architect or Engineer. However, no such implied meaning will be interpreted to extend the Architect's or Engineer's responsibility into the Contractor's area of construction supervision.
- E. Reviewed: Where used in conjunction with the Engineer's response to submittals, requests for information, applications, inquiries, reports and claims by the Contractor the meaning of the term "Reviewed" will be held to limitations of Architect's and Engineer's responsibilities and duties as specified in the General and Supplemental Conditions. In no case will "Reviewed" by Engineer be interpreted as a release of the Contractor from responsibility to fulfill the terms and requirements of the Contract Documents.
- F. Furnish: Except as otherwise defined in greater detail, the term "Furnish" is used to mean supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.
- G. Install: Except as otherwise defined in greater detail, the term "Install" is used to describe operations at the project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection, cleaning and similar operations, as applicable in each instance.
- H. Provide: Except as otherwise defined in greater detail, the term "Provide" is used to mean "Furnish and Install", complete and ready for intended use, as applicable in each instance.
- I. Installer: Entity (person or firm) engaged by the Contractor or its subcontractor or Sub-contractor for performance of a particular unit of work at the project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protection, cleaning and similar operations, as applicable in each instance. It is a general requirement that such entities (Installers) be expert in the operations they are engaged to perform.
- J. Imperative Language: Used generally in Specifications. Except as otherwise indicated, requirements expressed imperatively are to be performed by the Contractor. For clarity of reading at certain locations, contrasting subjective language is used to describe responsibilities that must be fulfilled indirectly by the Contractor, or when so noted by other identified installers or entities.
- K. Minimum Quality/Quantity: In every instance, the quality level or quantity shown or specified is intended as minimum quality level or quantity of work to be performed or provided. Except as otherwise specifically indicated, the actual work may either comply exactly with that minimum (within specified tolerances), or may exceed that minimum within reasonable tolerance limits. In complying with requirements, indicated or scheduled numeric values are either minimums or maximums as noted or as appropriate for the context of the requirements. Refer instances of uncertainty to Owner or Engineer via a request for information (RFI) for decision before proceeding.
- L. Abbreviations and Symbols: The language of Specifications and other Contract Documents including Drawings is of an abbreviated type in certain instances, and implies words and meanings which will be appropriately interpreted. Actual word abbreviations of a self explanatory nature have been included in text of Specifications and Drawings. Specific abbreviations and symbols have been established, principally for lengthy technical terminology and primarily in conjunction with coordination of Specification requirements with notations on Drawings and in Schedules. These are frequently defined in Section at first instance of use or on a Legend and Symbol Drawing. Trade and industry association names and titles of generally recognized industry standards are frequently abbreviated. Singular



words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of Contract Documents so indicate. Except as otherwise indicated, graphic symbols and abbreviations used on Drawings and in Specifications are those recognized in construction industry for indicated purposes. Where not otherwise noted symbols and abbreviations are defined by 1993 ASHRAE Fundamentals Handbook, chapter 34 "Abbreviations and Symbols", ASME and ASPE published standards.

#### 1.12 DRAWINGS AND SPECIFICATIONS

- A. These Specifications are intended to supplement the Drawings and it will not be the province of the Specifications to mention any part of the work which the Drawings are competent to fully explain in every particular and such omission is not to relieve the Contractor from carrying out portions indicated on the Drawings only.
- B. Should items be required by these Specifications and not indicated on the Drawings, they are to be supplied even if of such nature that they could have been indicated thereon. In case of disagreement between Drawings and Specifications, or within either Drawings or Specifications, the better quality or greater quantity of work shall be estimated and the matter referred to the Architect or Engineer for review with a request for information and clarification at least 7 working days prior to bid opening date for issuance of an addendum.
- C. The listing of product manufacturers, materials and methods in the various sections of the Specifications, and indicated on the Drawings, is intended to establish a standard of quality only. It is not the intention of the Owner or Engineer to discriminate against any product, material or method that is equal to the standards as indicated and/or specified, nor is it intended to preclude open, competitive bidding. The fact that a specific manufacturer is listed as an acceptable manufacturer should not be interpreted to mean that the manufacturers' standard product will meet the requirements of the project design, Drawings, Specifications and space constraints.
- D. The Architect or Engineer and Owner shall be the sole judge of quality and equivalence of equipment, materials and methods.
- E. Products by other reliable manufacturers, other materials, and other methods, will be accepted as outlined, provided they have equal capacity, construction, and performance. However, under no circumstances shall any substitution be made without the written permission of the Architect or Engineer and Owner. Request for prior approval must be made in writing 10 days prior to the bid date without fail.
- F. Wherever a definite product, material or method is specified and there is not a statement that another product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method is the only one that shall be used without prior approval.
- G. Wherever a definite material or manufacturer's product is specified and the Specification states that products of similar design and equal construction from the specified list of manufacturers may be substituted, it is the intention of the Owner or Engineer that products of manufacturers that are specified are the only products that will be acceptable and that products of other manufacturers will not be considered for substitution without approval.
- H. Wherever a definite product, material or method is specified and there is a statement that "OR EQUAL" product, material or method will be acceptable, it is the intention of the Owner or Engineer that the specified product, material or method or an "OR EQUAL" product, material or method may be used if it complies with the specifications and is submitted for review to the Engineer as outline herein.

- I. Where permission to use substituted or alternative equipment on the project is granted by the Owner or Engineer in writing, it shall be the responsibility of the Contractor or Subcontractor involved to verify that the equipment will fit in the space available which includes allowances for all required Code and maintenance clearances, and to coordinate all equipment structural support, plumbing and electrical requirements and provisions with the Mechanical (HVAC) and Plumbing Design Documents and all other trades, including Division 16.
- J. Changes in architectural, structural, electrical, mechanical, and plumbing requirements for the substitution shall be the responsibility of the bidder wishing to make the substitution. This shall include the cost of redesign by the affected designer(s). Any additional cost incurred by affected subcontractors shall be the responsibility of this bidder and not the owner.
- K. If any request for a substitution of product, material or method is rejected, the Contractor will automatically be required to furnish the product, material or method named in the Specifications. Repetitive requests for substitutions will not be considered.
- L. The Owner or Engineer will investigate all requests for substitutions when submitted in accordance with above and if accepted, will issue a letter allowing the substitutions.
- M. Where equipment other than that used in the design as specified or shown on the Drawings is substituted (either from an approved manufacturers list or by submittal review), it shall be the responsibility of the substituting Contractor to coordinate space requirements, building provisions and connection requirements with his trades and all other trades and pay all additional costs to other trades, the Owner, the Architect or Engineer, if any, due to the substitutions.**
- N. The electrical design and electrical drawings are based on the equipment and/or electric motors of the type, size and electrical characteristics shown and specified on the mechanical drawings. Any change in equipment and/or motor size or type brought on directly or indirectly by a substitution or mechanical equipment having characteristics requiring a change, shall be the responsibility of the Mechanical Contractor and the entire cost of such change, including conduit, wiring, motor starting equipment, etc., shall be paid for by the Mechanical Contractor at no additional charge, unless the substitution was initiated by the Owner. Submittals must clearly show and deviations. Mechanical Contractor is responsible for coordinating any required changes with the Electrical Contractor, prior to Electrical Contractors ordering of panels and associated equipment.**

#### 1.13 SUBMITTALS

- A. Coordinate with Division 1 for submittal timetable requirements, unless noted otherwise within thirty (30) days after the Contract is awarded the Contractor shall submit a minimum of eight (8) complete bound sets of shop drawings and complete data covering each item of equipment or material. The first submittal of each item requiring a submittal must be received by the Architect or Engineer within the above thirty day period. The Architect or Engineer shall not be responsible for any delays or costs incurred due to excessive shop drawing review time for submittals received after the thirty (30) day time limit. The Architect and Engineer will retain one (1) copy each of all shop drawings for their files. Where full size drawings are involved, submit one (1) print and one (1) reproducible sepia or mylar in lieu of eight (8) sets. All literature pertaining to an item subject to Shop Drawing submittal shall be submitted at one time. A submittal shall not contain information from more than one Specification section, but may have a section subdivided into items or equipment as listed in each section. The Contractor may elect to submit each item or type of equipment separately. Each submittal shall include the following items enclosed in a suitable binder:

1. A cover sheet with the names and addresses of the Project, Architect, MEP Engineer, General Contractor and the Subcontractor making the submittal. The cover sheet shall also contain the section number covering the item or items submitted and the item nomenclature or description.
  2. An index page with a listing of all data included in the Submittal.
  3. A list of variations page with a listing all variations, including unfurnished or additional required accessories, items or other features, between the submitted equipment and the specified equipment. If there are no variations, then this page shall state "NO VARIATIONS". Where variations affect the work of other Contractors, then the Contractor shall certify on this page that these variations have been fully coordinated with the affected Contractors and that all expenses associated with the variations will be paid by the submitting Contractor. This page will be signed by the submitting Contractor.
  4. Equipment information including manufacturer's name and designation, size, performance and capacity data as applicable. All applicable Listings, Labels, Approvals and Standards shall be clearly indicated.
  5. Dimensional data and scaled drawings as applicable to show that the submitted equipment will fit the space available with all required Code and maintenance clearances clearly indicated and labeled at a minimum scale of 1/4" = 1'-0", as required to demonstrate that the alternate or substituted product will fit in the space available.
  6. Identification of each item of material or equipment matching that indicated on the Drawings.
  7. Sufficient pictorial, descriptive and diagrammatic data on each item to show its conformance with the Drawings and Specifications. Any options or special requirements or accessories shall be so indicated. All applicable information shall be clearly indicated with arrows or another approved method.
  8. Additional information as required in other Sections of this Division.
  9. Certification by the General Contractor and Subcontractor that the material submitted is in accordance with the Drawings and Specifications, signed and dated in long hand. Submittals that do not comply with the above requirements shall be returned to the Contractor and shall be marked "REVISE AND RESUBMIT".
- B. Refer to Division 1 for additional information on shop drawings and submittals.
- C. Equipment and materials submittals and shop drawings will be reviewed for compliance with design concept only. It will be assumed that the submitting Contractor has verified that all items submitted can be installed in the space allotted. Review of shop drawings and submittals shall not be considered as a verification or guarantee of measurements or building conditions.
- D. Where shop drawings and submittals are marked "REVIEWED", the review of the submittal does not indicate that submittals have been checked in detail nor does it in any way relieve the Contractor from his responsibility to furnish material and perform work as required by the Contract Documents.
- E. Shop drawings shall be reviewed and returned to the Contractor with one of the following categories indicated:
1. REVIEWED: Contractor need take no further submittal action, shall include this submittal in the O&M manual and may order the equipment submitted on.
  2. REVIEWED AS NOTED: Contractor shall submit a letter verifying that required exceptions to the submittal have been received and complied with including additional accessories or coordination action as noted, and shall include this submittal and compliance letter in the O&M manual. The contractor may order the

- equipment submitted on at the time of the returned submittal providing the Contractor complies with the exceptions noted.
3. NOT APPROVED: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is not approved, the Contractor will automatically be required to furnish the product, material or method named in the Specifications and/or drawings. Contractor shall not order equipment that is not approved. Repetitive requests for substitutions will not be considered.
  4. REVISE AND RESUBMIT: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is marked revise and resubmit, the Contractor will automatically be required to furnish the product, material or method named in the Specifications and/or provide as noted on previous shop drawings. Contractor shall not order equipment marked revise and resubmit. Repetitive requests for substitutions will not be considered.
  5. CONTRACTOR'S CERTIFICATION REQUIRED: Contractor shall resubmit submittal on material, equipment or method of installation. The Contractor's stamp is required stating the submittal meets all conditions of the contract documents. The stamp shall be signed by the General Contractor. The submittal will not be reviewed if the stamp is not placed and signed on all shop drawings.
  6. MANUFACTURER NOT AS SPECIFIED: Contractor shall resubmit new submittal on material, equipment or method of installation when the alternate or substitute is marked manufacturer not as specified, the Contractor will automatically be required to furnish the product, material or method named in the specifications. Contractor shall not order equipment where submittal is marked manufacturer not as specified. Repetitive requests for substitutions will not be considered.
- F. Materials and equipment which are purchased or installed without shop drawing review shall be at the risk of the Contractor and the cost for removal and replacement of such materials and equipment and related work which is judged unsatisfactory by the Owner or Engineer for any reason shall be at the expense of the Contractor. The responsible Contractor shall remove the material and equipment noted above and replace with specified equipment or material at his own expense when directed in writing by the Architect or Engineer.
- G. Shop Drawing Submittals shall be complete and checked prior to submission to the Engineer for review.
- H. Submittals are required for, but not limited to, the following items:
1. Pipe Material and Specialties.
  2. Pipe Fabrication Drawings.
  3. Basic Materials.
  4. Variable Air Volume Boxes.
  5. Air Handling Units.
  6. Cooling Towers.
  7. Chillers.
  8. Air Cooled Condensing Units.
  9. Water Treatment.
  10. Expansion Compensation.
  11. Variable Frequency Drives.
  12. Noise and Vibration Controls.
  13. Plumbing Fixtures and Specialties.
  14. Plumbing Equipment.
  15. Sanitary DWV Fittings, Pipe and Accessories.
  16. Domestic Hot and Cold Water Pipe, Fittings and Accessories.
  17. HVAC Pipe and Duct Insulation.
  18. Hydronic and Plumbing Valves.
  19. Hydronic Piping and Accessories.

20. Hydronic Pumps.
21. Roof-Top A/C Units.
22. Heating Water Boiler.
23. Portable Pipe Hanger and Equipment Supports.
24. Duct Specialties.
25. Duct Fabrication Drawings.
26. Air Distribution Devices.
27. Fan Coil Units.
28. Filters.
29. Fans.
30. Fire Dampers and Fire Smoke Dampers.
31. Temperature Controls and Control Sequences.
32. Test, Adjust and Balance Reports.
33. Testing, Adjusting and Balancing Contractor Qualifications.
34. Coordination Drawings.

- I. Refer to other Division 15 sections for additional shop drawing requirements. Provide samples of actual materials and/or equipment to be used on the Project upon request of the Owner or Engineer.
- J. **Contractor to submit Mechanical/Electrical equipment coordination sheet with equipment submittal for all AHU's, ACCU's, and Fans. Reference chart at end of section. Provide copy to electrical subcontractor.**

#### 1.14 COORDINATION DRAWINGS

- A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
  1. Indicate the proposed locations of pipe, duct, equipment, and other materials. Include the following:
    - a. Wall and type locations.
    - b. Clearances for installing and maintaining insulation.
    - c. Locations of light fixtures and sprinkler heads.
    - d. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
    - e. Equipment connections and support details.
    - f. Exterior wall and foundation penetrations.
    - g. Routing of storm and sanitary sewer piping.
    - h. Fire-rated wall and floor penetrations.
    - i. Sizes and location of required concrete pads and bases.
    - j. Valve stem movement.
    - k. Structural floor, wall and roof opening sizes and details.
  2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
  3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
  4. Prepare reflected ceiling plans to coordinate and integrate installations, air distribution devices, light fixtures, communication systems components, and other ceiling-mounted items.

- B. This Contractor shall be responsible for coordination of all items that will affect the installation of the work of this Division. This coordination shall include, but not be limited to: voltage, ampacity, capacity, electrical and piping connections, space requirements, sequence of construction, building requirements and special conditions.
- C. By submitting shop drawings on the project, this Contractor is indicating that all necessary coordination has been completed and that the systems, products and equipment submitted can be installed in the building and will operate as specified and intended, in full coordination with all other Contractors and Subcontractors.

#### 1.15 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Special Project Requirements, in addition to the requirements specified in Division 15, indicate the following installed conditions:
  - 1. Duct mains and branches, size and location, for both exterior and interior; locations of dampers, fire dampers, duct access panels, and other control devices; filters, fuel fired heaters, fan coils, condensing units, and roof-top A/C units requiring periodic maintenance or repair.
  - 2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.
  - 3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
  - 4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
  - 5. Contract Modifications, actual equipment and materials installed.
- B. Engage the services of a Land Surveyor or Professional Engineer registered in the state in which the project is located as specified herein to record the locations and invert elevations of underground installations.
- C. The Contractor shall maintain a set of clearly marked black line record "AS-BUILT" prints on the job site on which he shall mark all work details, alterations to meet site conditions and changes made by "Change Order" notices. These shall be kept available for inspection by the Owner, Architect or Engineer at all times.
- D. Refer to Division 1 for additional requirements concerning record drawings. If the Contractor does not keep an accurate set of as-built drawings, the pay request may be altered or delayed at the request of the Architect. Mark the drawings with a colored pencil. Delivery of as-built prints and reproduces is a condition of final acceptance.
- E. The record prints shall be updated on a daily basis and shall indicate accurate dimensions for all buried or concealed work, precise locations of all concealed pipe or duct, locations of all concealed valves, controls and devices and any deviations from the work shown on the Construction Documents which are required for coordination. All dimensions shall include at least two dimensions to permanent structure points.
- F. Submit three prints of the tracings for approval. Make corrections to tracings as directed and delivered "Auto Positive Tracings" to the architect. "As-Built" drawings shall be furnished in addition to shop drawings.

- G. When the option described in paragraph F., above is not exercised then upon completion of the work, the Contractor shall transfer all marks from the submit a set of clear concise set of reproducible record "AS-BUILT" drawings and shall submit the reproducible drawings with corrections made by a competent draftsman and three (3) sets of black line prints to the Architect or Engineer for review prior to scheduling the final inspection at the completion of the work. The reproducible record "AS-BUILT" drawings shall have the Engineers Name and Seal removed or blanked out and shall be clearly marked and signed on each sheet as follows:

CERTIFIED RECORD DRAWINGS

DATE:

(NAME OF GENERAL CONTRACTOR)

BY: \_\_\_\_\_  
(SIGNATURE)

(NAME OF SUBCONTRACTOR)

BY: \_\_\_\_\_  
(SIGNATURE)

1.16 OPERATING MANUALS

- A. Prepare maintenance manuals in accordance with Division 1 and in addition to the requirements specified in Division 1, include the following information for equipment items:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
  2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
  3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
  4. Servicing instructions and lubrication charts and schedules.

1.17 CERTIFICATIONS AND TEST REPORTS

- A. Submit a detailed schedule for completion and testing of each system indicating scheduled dates for completion of system installation and outlining tests to be performed and schedule date for each test. This detailed completion and test schedule shall be submittal at least 90 days before the projected Project completion date.
- B. Test result reporting forms shall be submitted for review no later than the date of the detailed schedule submitted.
- C. Submit 4 copies of all certifications and test reports to the Architect or Engineer for review adequately in advance of completion of the Work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.
- D. Certifications and test reports to be submitted shall include, but not be limited to those items outlined in Section of Division 15.

## 1.18 MAINTENANCE MANUALS

- A. Coordinate with Division 1 for maintenance manual requirements, unless noted otherwise bind together in "D ring type" binders by National model no. 79-883 or equal, binders shall be large enough to allow  $\frac{1}{4}$ " of spare capacity. Three (3) sets of all approved shop drawing submittals, fabrication drawings, bulletins, maintenance instructions, operating instructions and parts exploded views and lists for each and every piece of equipment furnished under this Specification. All sections shall be typed and indexed into sections and labeled for easy reference and shall utilize the individual specification section numbers shown in the Mechanical Specifications as an organization guideline. Bulletins containing information about equipment that is not installed on the project shall be properly marked up or stripped and reassembled. All pertinent information required by the Owner for proper operation and maintenance of equipment supplied by Division 15 shall be clearly and legibly set forth in memoranda that shall, likewise, be bound with bulletins.
- B. Prepare maintenance manuals in accordance with Special Project Conditions, in addition to the requirements specified in Division 15, include the following information for equipment items:
  - 1. Identifying names, name tags designations and locations for all equipment.
  - 2. Valve tag lists with valve number, type, color coding, location and function.
  - 3. Reviewed shop drawing submittals with exceptions noted compliance letter.
  - 4. Fabrication drawings.
  - 5. Equipment and device bulletins and data sheets clearly highlighted to show equipment installed on the project and including performance curves and data as applicable, i.e., description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and model numbers of replacement parts.
  - 6. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
  - 7. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions, servicing instructions and lubrication charts and schedules.
  - 8. Equipment and motor name plate data.
  - 9. Wiring diagrams.
  - 10. Exploded parts views and parts lists for all equipment and devices.
  - 11. Color coding charts for all painted equipment and conduit.
  - 12. Location and listing of all spare parts and special keys and tools furnished to the Owner.
  - 13. Furnish recommended lubrication schedule for all required lubrication points with listing of type and approximate amount of lubricant required.
- C. Refer to Division 1 for additional information on Operating and Maintenance Manuals.
- D. Operating and Maintenance Manuals shall be turned over to the Owner or Engineer a minimum of 14 working days prior to the beginning of the operator training period.

## 1.19 OPERATOR TRAINING

- A. The Contractor shall furnish the services of factory trained specialists to instruct the Owner's operating personnel. The Owner's operator training shall include 12 hours of on site training in three 4 hour shifts.
- B. Before proceeding with the instruction of Owner Personnel, prepare a typed outline in triplicate, listing the subjects that will be covered in this instruction, and submit the outline for



review by the Owner. At the conclusion of the instruction period obtain the signature of each person being instructed on each copy of the reviewed outline to signify that he has a proper understanding of the operation and maintenance of the systems and resubmit the signed outlines.

- C. Refer to other Division 15 Sections for additional Operator Training requirements.

#### 1.20 FINAL COMPLETION

- A. At the completion of the work, all equipment and systems shall be tested and faulty equipment and material shall be repaired or replaced. Refer to Sections of Division 15 for additional requirements.
- B. Clean and adjust all air distribution devices and replace all air filters immediately prior to final acceptance.
- C. Touch up and/or refinish all scratched equipment and devices immediately prior to final acceptance.

#### 1.21 CONTRACTOR'S GUARANTEE

- A. Use of the HVAC and Plumbing systems to provide temporary service during construction period will not be allowed without permission from the Owner in writing and if granted shall not be cause warranty period to start, except as defined below.
- B. Contractor shall guarantee to keep the entire installation in repair and perfect working order for a period of one year after its completion and final acceptance, and shall furnish free of additional cost to the Owner all materials and labor necessary to comply with the above guarantee throughout the year beginning from the date of issue of Substantial Completion, Beneficial Occupancy by the Owner or the Certificate of Final Payment as agreed upon by all parties.
- C. This guarantee shall not include cleaning or changing filters except as required by testing, adjusting and balancing.
- D. All air conditioning compressors shall have parts and labor guarantees for a period of not less than 5 years beyond the date of final acceptance.
- E. Refer to Sections in Division 15 for additional guarantee or warranty requirements.

#### 1.22 TRANSFER OF ELECTRONIC FILES

- A. Project documents are not intended or represented to be suitable for reuse by Architect/Owner or others on extensions of this project or on any other project. Any such reuse or modification without written verification or adaptation by Engineer, as appropriate for the specific purpose intended, will be at Architect/Owner's risk and without liability or legal exposure to Engineer or its consultants from all claims, damages, losses and expense, including attorney's fees arising out of or resulting thereof.
- B. Because data stored in electric media format can deteriorate or be modified inadvertently, or otherwise without authorization of the data's creator, the party receiving the electronic files agrees that it will perform acceptance tests or procedures within sixty (60) days of receipt, after which time the receiving party shall be deemed to have accepted the data thus transferred to be acceptable. Any errors detected within the sixty (60) day acceptance period will be corrected by the party delivering the electronic files. Engineer is not responsible for

maintaining documents stored in electronic media format after acceptance by the Architect/Owner.

- C. When transferring documents in electronic media format, Engineer makes no representations as to the long term compatibility, usability or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by Engineer at the beginning of the Project.
- D. Any reuse or modifications will be Contractor's sole risk and without liability or legal exposure to Architect, Engineer or any consultant.
- E. The Texas Board of Architectural Examiners (TBAE) has stated that it is in violation of Texas law for persons other than the Architect of record to revise the Architectural drawings without the Architect's written consent.

It is agreed that "MEP" hard copy or computer-generated documents will not be issued to any other party except directly to the Architect/Owner. The contract documents are contractually copyrighted and cannot be used for any other project or purpose except as specifically indicated in AIA B-141 Standard Form of Agreement between Architect and Owner.

If the client, Architect/Owner, or developer of the project requires electronic media for "record purposes", then an AutoCAD based compact disc ("CD") will be prepared. The "CD" will be submitted with all title block references intact and will be formatted in a "plot" format to permit the end user to only view and plot the drawings. Revisions will not be permitted in this configuration.

- F. At the Architect/Owner's request, Engineer will prepare one "CD" of electronic media to assist the contractor in the preparation of submittals. The Engineer will prepare and submit the "CD" to the Architect/Owner for distribution to the contractor. All copies of the "CD" will be reproduced for a cost of reproduction fee of Five Hundred Dollars (\$500.00) per "CD".

The "CD" will be prepared and all title blocks, names and dates will be removed. The "CD" will be prepared in a ".dwg" format to permit the end user to revise the drawings.

- G. This Five Hundred Dollars (\$500.00) per "CD" cost of reproduction will be paid directly from the Contractor to the Engineer. The "CD" will be prepared only after receipt of the Five Hundred Dollars (\$500.00). The Five Hundred Dollars (\$500.00) per "CD" cost of reproduction is to only recover the cost of the manhours necessary to reproduce the documents. It is not a contractual agreement between the Contractor and Engineer to provide any engineering services, nor any other service.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Provide materials and equipment manufactured by a domestic United States manufacturer.
- B. Access Doors: Provide access doors as required for access to equipment, valves, controls, cleanouts and other apparatus where concealed. Access doors shall have concealed hinges and screw driver cam locks.
- C. All access panels located in wet areas such as restrooms, locker rooms, shower rooms, kitchen and any other wet areas shall be constructed of stainless steel.
- D. Access Doors: shall be as follows:

1. Plastic Surfaces: Milcor Style K.
2. Ceramic Tile Surface: Milcor Style M.
3. Drywall Surfaces: Milcor Style DW.
4. Install panels only in locations approved by the Architect.

### PART 3 - EXECUTION

#### 3.01 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected via reviewed submittals.
- B. Refer to equipment specifications in Divisions 2 through 16 for additional rough-in requirements.

#### 3.02 MECHANICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:
  1. Coordinate mechanical systems, equipment, and materials installation with other building components.
  2. Verify all dimensions by field measurements.
  3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
  4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
  5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
  6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
  7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
  8. Install systems, materials, and equipment to conform with architectural action markings on submittal, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, resolve conflicts and route proposed solution to the Architect for review.
  9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
  10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location and label.
  11. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified.
  12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

13. Provide roof curbs for all roof mounted equipment. Coordinate with roof construction for pitched roof. Provide roof curb to match roof slope. Refer to architectural drawings and details.
14. The equipment to be furnished under this Specification shall be essentially the standard product of the manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the product of the same manufacturer.
15. The architectural and structural features of the building and the space limitations shall be considered in selection of all equipment. No equipment shall be furnished which will not suit the arrangement and space limitations indicated.
16. Lubrication: Prior to start-up, check and properly lubricate all bearings as recommended by the manufacturer.
17. Where the word "Concealed" is used in these Specifications in connection with insulating, painting, piping, ducts, etc., it shall be understood to mean hidden from sight as in chases, furred spaces or suspended ceilings. "Exposed" shall be understood to mean the opposite of concealed.
18. Identification of Mechanical Equipment:
  - a. Mechanical equipment shall be identified by means of nameplates permanently attached to the equipment. Nameplates shall be engraved laminated plastic or etched metal. Shop drawings shall include dimensions and lettering format for approval. Attachments shall be with escutcheon pins, self-tapping screws, or machine screws.
  - b. Tags shall be attached to all valves, including control valves, with nonferrous chain. Tags shall be brass and at least 1-1/2 inches in diameter. Nameplate and tag symbols shall correspond to the identification symbols on the temperature control submittal and the "as-built" drawings.

### 3.03 CUTTING AND PATCHING

- A. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
- B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
  1. Uncover Work to provide for installation of ill-timed Work.
  2. Remove and replace defective Work.
  3. Remove and replace Work not conforming to requirements of the Contract Documents.
  4. Remove samples of installed Work as specified for testing.
  5. Install equipment and materials in existing structures.
  6. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer/Owner's observation of concealed Work, without additional cost to the Owner.
  7. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers; refer to the materials and methods required for the surface and building components being patched; Refer to Section "DEFINITIONS" for definition of "Installer."
- C. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, mechanical ducts and HVAC units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.

- D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

#### 3.04 WORK SEQUENCE, TIMING, COORDINATION WITH OWNER

- A. The Owner will cooperate with the Contractor, however, the following provisions must be observed:
  - 1. A meeting will be held at the project site, prior to any construction, between the Owner's Representative, the General Contractor, the Sub-Contractors and the Engineer to discuss Contractor's employee parking space, access, storage of equipment or materials, and use of the Owner's facilities or utilities. The Owner's decisions regarding such matters shall be final.
  - 2. During the construction of this project, normal facility activities will continue in existing buildings until renovated areas are completed. Plumbing, fire protection, lighting, electrical, communications, heating, air conditioning, and ventilation systems will have to be maintained in service within the occupied spaces of the existing building.

#### 3.05 DEMOLITION AND WORK WITHIN EXISTING BUILDINGS

- A. In the preparation of these documents every effort has been made to show the approximate locations of, and connections to the existing piping, duct, equipment and other apparatus related to this phase of the work. However, this Contractor shall be responsible for verifying all of the above information. This Contractor shall visit the existing site to inspect the facilities and related areas. This Contractor shall inspect and verify all details and requirements of all the Contract Documents, prior to the submission of a proposal. All discrepancies between the Contract Documents and actual job-site conditions shall be resolved by his contractor, who shall produce drawings that shall be submitted to the Architect/Engineer for review. All labor and materials required to perform the work described shall be apart of this Contract.
- B. All equipment and/or systems noted on the Drawings "To Remain" shall be inspected and tested on site to certify its working condition. A written report on the condition of all equipment to remain, including a copy of the test results and recommended remedial actions and costs shall be made by this Contractor to the Architect/Engineer for review.
- C. All equipment and/or systems noted on the Drawings "To Be Removed" shall be removed including, associated pipe and duct pipe and duct hangers and/or line supports. Where duct or pipe is to be capped for future or end of line use, it shall be properly tagged with its function or service appropriately identified. Where existing equipment is to be removed or relocated and has an electric motor or connection, the Electrical Contractor shall disconnect motor or connection, remove wiring to a safe point and this Contractor shall remove or relocate motor or connection along with the equipment.
- D. During the construction and remodeling, portions of the Project shall remain in service. Construction equipment, material tools, extension cords, etc., shall be arranged so as to present minimum hazard or interruption to the occupants of the building. None of the construction work shall interfere with the proper operation of the existing facility or be so conducted as to cause harm or danger to persons on the premises. All fire exits, stairs or corridors required for proper access, circulation or exit shall remain clear of equipment, materials or debris. The General Contractor shall maintain barricades, other separations in corridors and other spaces where work is conducted.

- E. Certain work during the demolition phase of construction may require overtime or night time shifts or temporary evacuation of the occupants. Coordinate and schedule all proposed down time at least seventy-two (72) hours in advance in writing.
- F. Any salvageable equipment as determined by the Owner, shall be delivered to the Owner, and placed in storage at the location of his choice. All other debris shall be removed from the site immediately.
- G. Equipment, piping or other potential hazards to the working occupants of the building shall not be left overnight outside of the designated working or construction area.
- H. Make every effort to minimize damage to the existing building and the owner's property. Repair, patch or replace as required any damage that might occur as a result of work at the site. Care shall be taken to minimize interference with the Owner's activities during construction and to keep construction disrupted areas to a minimum. Coordinate with the Owner and other trades in scheduling and performance of the work.
- I. Include in the contract price all rerouting of existing pipe, duct, etc., and the reconnecting of the existing equipment and plumbing fixtures as necessitated by field conditions to allow the installation of the new systems regardless of whether or not such rerouting, reconnecting or relocating is shown on the drawings. Furnish all temporary pipe, duct, controls, etc., as required to maintain heating, cooling, ventilation and plumbing services for the existing areas with a minimum of interruption.
- J. All existing plumbing fixtures, pipe, duct, materials, equipment, controls and appurtenances not included in the remodel or alteration areas are to remain in place.
- K. Pipe, duct, equipment and controls serving mechanical, plumbing and owner's equipment, etc., which is to remain but which is served by pipe, duct, equipment and controls that are disturbed by the remodeling work, shall be reconnected in such a manner as to leave this equipment in proper operating condition.
- L. It is the intention of this Section of the Specifications to outline minimum requirements to furnish the Owner with a turn-key and operating system in cooperation with other trades with a minimum of disruption or downtime.
- M. Refer to Architectural "Demolition and/or Alteration" plans for actual location of walls, ceiling, etc., being removed and/or remodeled.

**END OF SECTION**

<b>Mech/Elec. Equipment Coordination Sheet</b>					
<b>Mark #</b>	<b>Unit Type</b>	<b>Manufacturer's Recomm. Fuse Size (MOCP)</b>	<b>Mark #</b>	<b>Unit Type</b>	<b>Manufacturer's Recomm. Fuse Size (MOCP)</b>



## **SECTION 15051**

### **STARTING OF SYSTEMS**

#### **PART 1 - GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Starting systems.
- B. Demonstration and instructions.
- C. Testing, adjusting, and balancing.

##### **1.02 RELATED SECTIONS**

- A. Section 01400 - Quality Control: Manufacturers field reports.
- B. Section 01700 - Contract Closeout: System operation and maintenance data and extra materials.
- C. Section 15950 – Automatic Temperature Controls.
- D. Section 15990 - Testing, Adjusting and Balancing.

##### **1.03 STARTING SYSTEMS**

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Architect, Engineer and Owner seven days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or for other conditions that may cause damage.
- D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Adjust electrical amp draw on motors to within 80% of rated amp draw.
- F. Verify wiring and support components for equipment are complete and tested.
- G. Execute start-up under supervision of applicable manufacturer's representative in accordance with manufacturers' instructions.
- H. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- I. Adjust return air to 500 fpm at each air unit inlet. Replace drive packages as necessary to achieve design airflows.
- J. Submit a written report in accordance with Section 01400 that equipment or system has been properly installed and is functioning correctly.

##### **1.04 DEMONSTRATION AND INSTRUCTIONS**



- A. Demonstrate operation and maintenance of Products to Owner's personnel two weeks prior to date of final inspection.
- B. Demonstrate Project equipment and provide instruction by a qualified manufacturers' representative who is knowledgeable about the Project.
- C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.
- E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed time, at equipment location.
- F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

1.05 TESTING, ADJUSTING, AND BALANCING

- A. Mechanical Division will secure the services of an independent firm to perform testing, adjusting, and balancing.
- B. The independent firm will perform services specified in Section 15990.
- C. Reports will be submitted by the independent firm to the Architect/Engineer indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the Contract Documents.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

## **SECTION 15070 INSIDE UTILITY TRENCH EXCAVATION, BACKFILL, AND COMPACTION**

### **PART 1 – GENERAL**

#### **1.01 DESCRIPTION**

- A. This section describes general requirements, products, and methods of execution relating to excavation, backfill and compaction of inside trenches for mechanical work. Inside trenches are those which occur within an arbitrary, imaginary boundary five feet beyond the outside perimeter of the structure.SG
- B. Scope: Provide all trench work for mechanical work of every description and of whatever substance encountered to the depth indicated, or to provide pipe slopes and elevations shown on the drawing. Excavate and backfill utility trenches. Place and compact bedding material. Compact backfill material.
- C. SPECIAL NOTE: All provisions and divisions of these specifications are a part of this section of these specifications. The Contractor shall consult these divisions and provisions in detail for instructions and include all items pertaining to this work. The Contractor shall consult all other divisions of these specifications, determine the extent of impact on the work required to complete the work required by this section of the specifications or portion thereof and related work shown on the drawings.

#### **1.02 APPLICABLE CODES**

- A. Local Codes and Ordinances
- B. Texas Safety Standards
- C. OSHA – Section 1926.650

#### **1.03 SAFETY PRECAUTIONS AND PROGRAMS**

- A. It shall be the duty and responsibility of the Contractor and all of its subcontractors to be familiar and comply with all requirements of Public Law 91-696, 29 U.S.C. Secs. 651 et. seq., the Occupational Safety and Health Act of 1970, (OSHA) and all amendments thereto, and to enforce and comply with all of these provisions of this Act. IN ADDITION, ON PROJECTS IN WHICH TRENCH EXCAVATION WILL EXCEED A DEPTH OF FIVE FEET, THE CONTRACTOR AND ALL OF ITS SUBCONTRACTORS SHALL COMPLY WITH ALL REQUIREMENTS OF 29 C.F.R. SECS. 1926.652 AND 1926.653, OSHA SAFETY AND HEALTH STANDARDS.

### **PART 2 – BEDDING MATERIAL**

#### **2.01 BEDDING MATERIAL**

- A. Select bedding material from trench excavation using care to separate it from unsuitable material. If suitable bedding material is not available from trench excavation, import it from sources approved by the Architect.
- B. Use clean sand. Maintain moisture content within a range that will allow specified compaction.

#### **2.02 TRENCH BACKFILL**

- A. Obtain trench backfill material from trench excavation. If sufficient suitable trench backfill material compatible with structural backfill is not available from trench excavation, import it from sources approved by Architect.
- B. Use granular material, free from large stones, boulders and debris. Maintain moisture content within a range that will allow specified compaction. Maximum aggregate size four inches (4").

### **PART 3 – EXECUTION**

#### **3.01 EXCAVATION**

- A. Place all excavated material suitable for backfill in an orderly manner, and in conformance with safety codes.
- B. Dispose of all material not suitable for backfilling.
- C. Form bell holes so pipelines rest on continuous undisturbed soil. If larger rocks or boulders are encountered, remove them. If trenches are below specified grade, backfill to required depth with select granular materials free from debris and rock, and compact to proper grade before installing piping.

#### **3.02 LOCATION**

- A. Locate trenches to accommodate utilities shown on drawings
- B. Construct trench with adequate width to allow compaction equipment to be used at the sides of pipes.
- C. Make trench side slopes conform to prevailing safety code requirements.

#### **3.03 DEWATERING**

- A. Perform whatever work is necessary to prevent the flow and accumulation of surface or ground water in the excavation.

#### **3.04 TIMING**

- A. Do not backfill until underground mechanical system has been properly tested, inspected and approved.
- B. Coordinate with the work of others, and complete all trench work in a timely manner.

#### **3.05 BEDDING**

- A. Place bedding material under, around, and over the pipe in lifts not exceeding 8" in depth,
- B. Work material around pipe by hand methods, taking care to keep any oversize or sharp stones out of contact with the pipe, and to provide uniform support for the pipe.
- B. Cover pipe with bedding material to building subgrade or to a minimum 12" depth before adding other backfill.

#### **3.06 BACKFILLING**

- A. Continue placing backfill material until trench is completely filled to building subgrade, or as shown on drawings.
- B. Place backfill material in lifts not to exceed 12" in depth.

### 3.07 COMPACTION

- A. Compact all bedding material to at least 95% of maximum density, taking care not to damage the pipe.
- B. Compact all backfill under footings, slabs, and other structures to 95% of maximum density or more, if required by the Architect.
- C. Compact other areas to preclude future settlements, or at least 85% of maximum density.

### 3.08 FINISHING

- A. After completion of backfilling, dispose of excess material and smooth the surface of grade.
- B. Do not allow heavy equipment to be used over backfilled work that does not have sufficient cover to prevent pipe damage.

### 3.09 SPECIAL PRECAUTIONS

- A. Avoid unauthorized and unnecessary excavations.
- B. Minimize number and size of excavations under footings or bearing walls.
- C. Support footings, foundations, and walls with timbers and jacks if there appears to be any possible chance of damage, and keep such precautions in place to eliminate possible damage.
- D. Backfill under footings and bearing walls, using maximum compaction or concrete or proportions as specified for footings.
- E. Avoid damage to all existing underground services, foundations, cables, conduit lines or foundations. Repair any existing underground work accidentally damaged at no additional cost to the Owner.

### 3.10 UNDER EXISTING SLAB INSTALLATION

- A. When breaking out an existing floor slab, make a saw cut and remove concrete. When repouring concrete, compact the fill to the same specifications as the building fill. Re: Architectural/Structural. Make necessary saw cuts and patching as required.

**END OF SECTION**

## **SECTION 15080 OUTSIDE UTILITY TRENCH EXCAVATION, BACKFILL, AND COMPACTION**

### **PART 1 – GENERAL**

#### **1.01 DESCRIPTION OF WORK**

- A. Related Work Specified Elsewhere:
  - 1. Section 15010 – General Provisions
  - 2. Section 15050 – Basic Materials and Methods
  - 3. Division 2 – Site Work
- B. Description: This section described general requirements, products, and methods of execution relating excavation, backfill, and compaction of utility trenches outside of buildings. The arbitrary line of demarcation between inside and outside of buildings occurs 5' outside the building perimeters.
- C. It shall be the duty and responsibility of the Contractor and all of its subcontractors to be familiar and comply with all requirements of Public Law 91-696, 29 U.S.C. Secs. 651 et. seq., the Occupational Safety and Health Act of 1970, (OSHA) and all amendments thereto, and to WHICH TRENCH EXCAVATION WILL EXCEED A DEPTH OF FIVE FEET, THE CONTRACTOR AND ALL OF ITS SUBCONTRACTORS SHALL COMPLY WITH ALL REQUIREMENTS OF 29 C.F.R. SECS. 1926.652 AND 1926.653, OSHA SAFETY AND HEALTH STANDARDS.
- D. SPECIAL NOTE: All provisions and divisions of these specifications are a part of this section of these specifications. The Contractor shall consult these divisions and provisions in detail for instructions and include all items pertaining to this work. The Contractor shall consult all other divisions of these specifications, determine the extent of impact on the work required to complete the work required by this section of the specifications or portion thereof and related work shown on the drawings.

### **PART 2 – PRODUCTS**

#### **2.01 BEDDING MATERIAL**

- A. Select bedding material from trench excavation using care to separate it from unsuitable material. If suitable bedding material is not available from trench excavation, import it from sources approved by the Architect.
- B. Use granular material, free from large stones, boulders and debris. Maximum aggregate size passing a 2" sieve opening. Maintain moisture content within a range that will allow specified compaction.

#### **2.02 TRENCH BACKFILL**

- A. Obtain trench backfill material from trench excavation. If sufficient suitable trench backfill material is not available from trench excavation, import it from sources approved by the Architect.
- B. Use granular material, free from large stones, boulders, and debris. Maintain moisture content within range that will allow specified compaction. Maximum aggregate size 4 inches.

## **PART 3 – EXECUTION**

### **3.01 EXCAVATION**

- A. Excavate trenches to depth and grades as shown on drawings.
- B. Place all excavated material suitable for backfill in an orderly manner and in conformance with safety codes.
- C. Dispose of all material not suitable for backfill.
- D. Form bell holes so pipelines rest on continuous undisturbed soil. If larger rocks or boulders are encountered, remove them. If ground surface is below specified pipe grade, fill to required depth with granular materials free from debris and rock, and compact to proper grade before installing piping.

### **3.02 LOCATION**

- A. Locate trenches to accommodate utilities shown on the drawings.
- B. Construct trench with adequate width to allow compaction equipment to be used at the side of pipes.
- B. Make trench side slopes conform to prevailing safety code requirements.

### **3.03 DE-WATERING**

- A. Perform whatever work is necessary to prevent flow and accumulation of surface or ground water in the excavation.

### **3.04 TIMING**

- A. Do not complete backfill until utility system has been properly tested, inspected, and approved.
- B. Coordinate with the work of others and complete all trench work in a timely manner.

### **3.05 BEDDING**

- A. Place bedding material under, around, and over pipe in lifts not exceeding 8" in depth.
- B. Work material around pipe by hand methods, taking care to keep any oversize or sharp stones out of contact with the pipe, and provide uniform support for the pipe.
- C. Cover pipe with bedding material to a minimum 6" depth before adding other backfill.
- D. Cover water line with 18" bedding material before backfilling.

### **3.06 BACKFILLING**

- A. Continue placing backfill material until trench is completely filled to finished grade, or as shown on the drawing.
- B. Place backfill material in lifts not to exceed 12" in depth.

3.07 COMPACTION

- A. Compact all bedding material to at least 95% of maximum density, taking care not to damage the pipe.
- B. Compact backfill material to preclude future settlement or at least to 90% of maximum density.

3.08 FINISHING

- A. After completion of backfilling, dispose of excess material and smooth the surface to grade.
- B. Restore all surface areas to original conditions, or improve as shown on the drawings. Replace all paving, base course, gravel surfacing, sub-base, topsoil or other existing finished surface as shown on drawings.
- C. Clean up and finish all construction areas to original condition or better.

**END OF SECTION**

**SECTION 15140**  
**SUPPORTS AND ANCHORS**

**PART 1 - GENERAL**

**1.01 WORK INCLUDED**

- A. Pipe, and equipment hangers, supports, and associated anchors.
- B. Sleeves and seals.
- C. Flashing and sealing equipment and pipe stacks.

**1.02 RELATED WORK**

- A. Section 15240 - Vibration Isolation.
- B. Section 15260 - Piping Insulation.
- C. Section 15280 - Equipment Insulation.
- D. Section 15310 - Fire Protection System.
- E. Section 15410 - Plumbing System.
- F. Section 15510 - Hydronic Piping.
- G. Section 15530 – Refrigerant Piping

**1.03 REFERENCES**

- A. ANSI/ASME B31.1 - Power Piping.
- B. NFPA 13 - Standard for the Installation of Sprinkler Systems.
- C. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.

**1.04 QUALITY ASSURANCE**

- A. Supports for Sprinkler Piping: In conformance with NFPA 13.
- B. Supports for Standpipes: In conformance with NFPA 14.

**1.05 SUBMITTALS**

- A. Submit shop drawings and product data under provisions of Division One.
- B. Indicate hanger and support framing and attachment methods.

**PART 2 - PRODUCTS**

**2.01 PIPE HANGERS AND SUPPORTS**

- A. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch Malleable iron, adjustable swivel, split ring.



- B. Hangers for Pipe Sizes 2 to 4 Inches Carbon steel, adjustable, clevis.
- C. Hangers for Pipe Sizes 6 Inches and over: Adjustable steel yoke, cast iron roll, double hanger.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods; cast iron roll and stand for pipe sizes 6 inches and over.
- E. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- F. Wall Support for Pipe Sizes 4 Inches and over: adjustable steel yoke and cast iron roll.
- G. Vertical Support: Steel riser clamp.
- H. Floor Support for Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.
- I. Floor Support for Pipe Sizes 6 Inches and over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- J. Roof Pipe Supports and Hangers: Galvanized Steel Channel System as manufactured by Portable Pipe Hangers, Inc. or approved equal.  
  
For pipes 2-1/2" and smaller – Type PP10 with roller  
For pipes 3" through 8" – Type PS  
For multiple pipes – Type PSE - Custom
- K. Copper Pipe Support and Hangers: Electro-galvanized with thermoplastic elastomer cushions; Unistrut "Cush-A-Clamp" or equal. Hangers: Plastic coated; Unistrut or equal.
- L. For installation of protective shields refer to specification section 15140-3.03.
- M. Shields for Vertical Copper Pipe Risers: Sheet lead.
- N. Pipe Rough-In Supports in Walls/Chases: Provide preformed plastic pipe supports, Sioux Chief "Pipe Titan" or equal.

## 2.02 HANGER RODS

- A. Galvanized Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

## 2.03 INSERTS

- A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

## 2.04 FLASHING

- A. Metal Flashing: 20 gage galvanized steel.
- B. Lead Flashing: 4 lb./sq. ft. sheet lead for waterproofing; 1 lb./sq. ft. sheet lead for soundproofing.
- C. Caps: Steel, 20 gage minimum; 16 gage at fire resistant elements.

- D. Coordinate with roofing contractor/architect for type of flashing on metal roofs.

## 2.05 EQUIPMENT CURBS

- A. Fabricate curbs of hot dipped galvanized steel.

## 2.06 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: Form with 18 gage galvanized steel, tack welded to form a uniform sleeve.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Form with steel pipe, schedule 40.
- C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fireproofing: Prefabricated fire rated steel sleeves including seals, UL listed.
- D. Sleeves for Round Ductwork: Form with galvanized steel.
- E. Sleeves for Rectangular Ductwork: Form with galvanized steel.
- F. Fire Stopping Insulation: Glass fiber type, non-combustible, U.L. listed.
- G. Caulk: Paintable 25-year acrylic sealant.
- H. Pipe Alignment Guides: Factory fabricated, of cast semi-steel or heavy fabricated steel, consisting of bolted, two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

## 2.07 FABRICATION

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- B. Design hangers without disengagement of supported pipe.
- C. Design roof supports without roof penetrations, flashing or damage to the roofing material.

## 2.08 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

## PART 3 - EXECUTION

### 3.01 INSERTS

- A. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams. Coordinate with structural engineer for placement of inserts.
- B. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
- C. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.

- D. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab. Verify with structural engineer prior to start of work.

### 3.02 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as follows:

<u>PIPE SIZE</u>	<u>MAX. HANGER SPACING</u>	<u>HANGER DIAMETER</u>
(Steel Pipe)		
1/2 to 1-1/4 inch	7'-0"	3/8"
1-1/2 to 3 inch	10'-0"	3/8"
4 to 6 inch	10'-0"	1/2"
8 to 10 inch	10'-0"	5/8"
12 to 14 inch	10'-0"	3/4"
15 inch and over	10'-0"	7/8"
(Copper Pipe)		
1/2 to 1-1/4 inch	5'-0"	3/8"
1-1/2 to 2-1/2 inch	8'-0"	3/8"
3 to 4 inch	10'-0"	3/8"
6 to 8 inch	10'-0"	1/2"
(Cast Iron)		
2 to 3 inch	5'-0"	3/8"
4 to 6 inch	10'-0"	1/2"
8 to 10 inch	10'-0"	5/8"
12 to 14 inch	10'-0"	3/4"
15 inch and over	10'-0"	7/8"
(PVC Pipe)		
1-1/2 to 4 inch	4'-0"	3/8"
6 to 8 inch	4'-0"	1/2"
10 and over	4'-0"	5/8"

- B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- C. Place a hanger within 12 inches of each horizontal elbow and at the vertical horizontal transition.

- D. Use hangers with 1-1/2 inch minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Install hangers with nut at base and above hanger; tighten upper nut to hanger after final installation adjustments.
- J. Portable pipe hanger systems shall be installed per manufactures instructions.

3.03 Insulated Piping: Comply with the following installation requirements.

- A. Clamps: Attach galvanized clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
- B. Saddles: Install galvanized protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
- C. Shields: Install protective shields MSS Type 40 on cold and chilled water piping that has vapor barrier. Shields shall span an arc of 180 degrees and shall have dimensions in inches not less than the following:

<u>NPS</u>	<u>LENGTH</u>	<u>THICKNESS</u>
1/4 THROUGH 3-1/2	12	0.048
4	12	0.060
5 & 6	18	0.060
8 THROUGH 14	24	0.075
16 THROUGH 24	24	0.105

- D. Piping 2" and larger provide galvanized sheet metal shields with calcium silicate at hangers/supports.
- E. Insert material shall be at least as long as the protective shield.
- F. Thermal Hanger Shields: Install where indicated, with insulation of same thickness as piping.

3.04 EQUIPMENT BASES AND SUPPORTS

- A. Provide equipment bases of concrete.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct support of steel members. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.

### 3.05 FLASHING

- A. Provide flexible flashing and metal counter flashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 8 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter flash and seal.
- C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
- D. Seal floor shower mop sink and all other drains watertight to adjacent materials.
- E. Provide curbs for mechanical roof installations 8 inches minimum high above roofing surface. Contact architect for all flashing details and roof construction. Seal penetrations watertight.

### 3.06 SLEEVES

- A. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- B. Extend sleeves through floors minimum one inch above finished floor level. Caulk sleeves full depth with fire rated thermfiber and 3M caulking and provide floor plate.
- C. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with U.L. listed fire stopping insulation and caulk seal air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- D. Fire protection sleeves may be flush with floor of stairways.

**END OF SECTION**

## **SECTION 15170**

### **MOTORS**

#### **PART 1 - GENERAL**

##### **1.01 GENERAL REQUIREMENTS**

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 15050, are included as a part of this Section as though written in full in this document.

##### **1.02 SCOPE**

- A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.
- B. WORK SPECIFIED ELSEWHERE:
  - 1. Painting
  - 2. Automatic temperature controls.
  - 3. Power control wiring to motors and equipment.

##### **1.03 WARRANTY**

Warrant the Work specified herein for one year and motors for five years beginning on date of substantial completion against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.

##### **1.04 SUBMITTALS**

- A. SHOP DRAWINGS: Indicate size material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.
- B. PRODUCT DATA: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures variations, and accessories.
- C. MOTOR NAMEPLATE INFORMATION: Manufacturer's name, address, utility and operating data.
- D. Refer to Division One for additional information.

##### **1.05 DELIVERY AND STORAGE**

- A. DELIVERY: Deliver clearly labeled, undamaged materials in the manufacturers' unopened containers.
- B. TIME AND COORDINATION: Deliver materials to allow for minimum storage time at the project site. Coordinate delivery with the scheduled time of installation.
- C. STORAGE: Store materials in a clean, dry location, protected from weather and abuse.

#### **PART 2 - PRODUCTS**

## 2.01 ELECTRIC MOTORS

A. APPROVED MANUFACTURERS: Provide motors by a single manufacturer as much as possible.

1. Baldur
2. Marathon
3. Siemens-Allis
4. General Electric
5. U.S. Motor

B. TEMPERATURE RATING: Provide insulation as follows:

1. CLASS B: 40 degrees C maximum.
2. CLASS F:
  - a. Between 40 degrees C and 65 degrees C maximum.
  - b. Totally enclosed motors.

C. STARTING CAPABILITY: As required for service indicated five starts minimum per hour.

D. PHASES AND CURRENT: Verify electrical service compatibility with motors to be used.

1. UP TO 1/2 HP: Provide permanent split, capacitor-start single phase with inherent overload protection.
2. 3/4 HP AND LARGER: Provide squirrel-cage induction polyphase.
3. Provide two separate windings on 2-speed polyphase motors.
4. Name plate voltage shall be the same as the circuit's normal voltage, serving the motor.

E. SERVICE FACTOR: 1.15 for poly-phase; 1.35 for single phase.

F. FRAMES: U-frames 1.5 Hp. and larger.

G. BEARINGS: Provide sealed re-graspable ball bearings; with top mounted oil mite lubrication fittings and bottom side drains minimum average life 100,000 hours typically, and others as follows:

1. Design for thrust where applicable.
2. PERMANENTLY SEALED: Where not accessible for greasing.
3. SLEEVE-TYPE WITH OIL CUPS: Light duty fractional hp. motors or polyphase requiring minimum noise level.

H. ENCLOSURE TYPE: Provide enclosures as follows:

1. CONCEALED INDOOR: Open drip proof.
2. EXPOSED INDOOR: Guarded.
3. OUTDOOR TYPICAL: Type II. TEC.
4. OUTDOOR WEATHER PROTECTED: Type I. TEA.

I. OVERLOAD PROTECTION: Built-in sensing device for stopping motor in all phase legs and signaling where indicated for fractional horse power motors.

J. NOISE RATING: "Quiet" except where otherwise indicated.

K. EFFICIENCY: Minimum full load efficiency listed in the following table, when tested in accordance with IEEE Test Procedure 112A, Method B, including stray load loss measure.

Motor Horsepower	NEMA Efficiency INDEX Letter	Minimum Efficiency %
1800 RPM Synchronous Speed		
7.5-10	F	89.5
15-20	E	91.0
25-30	E	92.4
40	D	93.0
50	C	93.0
60	C	93.6
75	C	94.1
100-125	B	94.5
150-200	B	95.0
1200 RPM Synchronous Speed		
3-5	G	87.5
7.5	G	89.5
10	F	89.5
15	F	90.2
20	E	90.2
25-30	E	91.7
40-50	D	93.0
60	D	93.6
75	C	93.6
100-125	C	94.1
150-200	B	95.0

### PART 3 - EXECUTION

- 3.01 All equipment shall be installed in accordance with the manufacturers' recommendations and printed installation instructions.
- 3.02 All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Contractors' price shall include all items required as per manufacturers' requirements.
- 3.03 INSTALLATION
- A. GENERAL: Install in a professional manner. Any part or parts not meeting this requirement shall be replaced or rebuilt without extra expense to Owner.
  - B. Install rotating equipment in static and dynamic balance.
  - C. Provide foundations, supports, and isolators properly adjusted to allow minimum vibration transmission within the building.
  - D. Correct objectionable noise or vibration transmission in order to operate equipment satisfactorily as determined by the Engineer.

### END OF SECTION



## **SECTION 15171**

### **COMBINATION AND NON-COMBINATION MOTOR STARTERS**

#### **PART 1 - GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Motor Controllers – Combination and Non-combination Motor Starters
- B. Furnish and install a complete motor controller for the following item(s):
  - 1. Constant volume air handling units
  - 2. Constant volume pumps
  - 3. Constant volume supply and exhaust fans.

##### **1.02 RELATED SECTIONS**

- A. Section 15050 – Basic Materials and Methods
- B. Section 15170 – Motors
- C. Section 15240 – Sound and Vibration Control
- D. Section 15855 – Air Handling Unit
- E. Section 15950 – Controls
- F. Section 15990 – Testing, Adjusting and Balancing
- G. Section 16075 – Electrical Identification

##### **1.03 SUBMITTALS**

- A. Manufacturer shall provide copies of the following documents:
  - 1. Product data sheets on specified products.
  - 2. Shop drawings for specified product.
  - 3. Wiring Schematics for specified products.
  - 4. Installation instructions.

##### **1.04 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01782 "Operation and Maintenance Data," include the following:
  - 1. Routine maintenance requirements for enclosed controllers and installed components.
  - 2. Provide manufacture's written instructions for testing and adjusting circuit breaker and Motor Circuit Protection trip settings of combination controllers.
  - 3. Provide manufacturer's written instructions for setting field-adjustable overload relays.
  - 4. Provide manufacture's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

##### **1.05 MATERIALS MAINTENANCE SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

#### 1.06 QUALIFICATIONS

- A. Manufacturer must have minimum of 20 years of documented experience, specializing in combination and non-combination starters.
- B. The starter assembly shall be UL listed under UL 508A

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Accept starters on site in original packing. Inspect for damage.
- B. Store in a clean, dry space. Maintain factory wrapping, or provide additional heavy canvas, or heavy plastic cover, to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully, in accordance of manufacturer's written instruction, to avoid damage to components, enclosure, and finish.

#### 1.08 WARRANTY

- A. Manufacturer shall provide a five year warranty on the complete starter assembly.

### PART 2 - PRODUCTS

#### 2.01 SECTION INCLUDES:

- A. Enclosed FVNR combination single phase motor starter with electronic overload relay
- B. Enclosed FVNR non-combination motor starters with electronic overload relay
- C. Enclosed FVNR combination motor starters with electronic overload relay
- D. Enclosed FVNR Two-Speed motor starters with electronic overload relay

#### 2.02 REFERENCES

- A. The starters referenced in this section are designed and manufactured to the following standards unless otherwise noted:
  1. ANSI/NFPA -70, National Electric Code
  2. UL 508, and UL508A Industrial Control Equipment
  3. NEMA ICS-2, 2000
  4. IEC 60947-5, 60947-4, 60947-3

#### 2.03 APPROVED MANUFACTURERS: Provide one of the following manufacturer's.

1. Cerus Industrial.
2. Square D.
3. Cutler Hammer.
4. ABB

## 2.04 SYSTEM DESCRIPTION

- A. Single Phase Starter: Starters for 115VAC single phase motors less than 1 HP shall be capable of both manual and automatic operation. Refer to Section 2.03.1 for single phase starter requirements.
- B. Magnetic Starters: Starters for 3-phase motors shall be magnetic starters. Refer to Section 2.03.2 for magnetic starter requirements.
- C. Combination Starters: Provide combination magnetic starters for all motors requiring branch circuit protection or a line-of-sight disconnect. Refer to Section 2.03.3 for combination magnetic starter requirements.

### 2.04.1 ENCLOSED FULL VOLTAGE NON-REVERSING (FVNR) SINGLE PHASE STARTER

- A. Single Phase Motor Starter Control: The single phase motor starter shall consist of a manually operated quick-make toggle mechanism lockable in the "Off" position which shall also function as the motor disconnect. Additionally, the starter shall provide thermal overload protection, run status pilot light and fault pilot light. The starter must include the capability to operate in both manual and automatic control modes. In automatic mode, the starter shall have the capability to integrate with a building automation system by providing terminals for run input, run status output and fault output. All control terminals shall be integrated in the starter. At a minimum, each single phase starter shall include an interposing run relay and current sensing status output relay. Single phase motor starter shall be in a surface mount enclosure.
- B. Approved manufacturer: Cerus Industrial, model BAS-1P or approved equal.

### 2.04.2 ENCLOSED FULL VOLTAGE NON-REVERSING (FVNR) NON-COMBINATION STARTER

- A. Magnetic Motor Starters shall be enclosed in a general purpose electrical enclosure with the appropriate environmental rating.
- B. Starters shall consist of a horsepower rated magnetic contactor with a minimum of 1NO and 1NC auxiliary contacts and solid state electronic overload relay. Overload relay shall protect all three phases with a wide range current setting and trip class to allow field adjustment for specific motor FLA. Interchangeable heater elements are not acceptable. Overload relay shall provide phase failure, phase loss, locked rotor and stall protection.
- C. Provide a manual reset pushbutton on the starter cover to restore normal operation after a trip or fault condition.
- D. Each starter shall include an installed 50VA control power transformer (CPT) with protected secondary. The CPT must accept the available line voltage and the control voltage shall not exceed 120V.
- E. Installed accessories shall include Hand-Off-Auto operation switch with 22mm style operator interfaces. Include LED pilot light indicators for Hand, Off, Auto, Run and Overload conditions. All pilot devices shall be water tight and dust tight.
- F. When remotely controlled by an automation system, the starter shall include remote run terminals which accept both a voltage input signal and a contact closure. The voltage run input shall accept both AC and DC signals including 24VAC, 120VAC, 24VDC and 48VDC to allow direct connection of the transistorized automation signal to the starter.
- G. In applications where the motor is interlocked with a damper or valve, the actuator control must reside within the starter enclosure. The starter must provide a voltage output to operate the actuator to open the damper or valve without closing the motor circuit. The starter will only

close the motor circuit and start the motor after it has received a contact closure from a limit or end switch confirming the damper or valve position.

- H. The starter shall provide a provision for Fireman's Override operation. When activated, the starter run the motor in any mode (Hand, Off or Auto) regardless of other inputs or lack of inputs either manual or auto. The purpose of the Fireman's Override input is to act as a smoke purge function. Fireman's Override has priority over the Emergency Shutdown input.
- I. If the starter is controlled by a fire alarm or life safety system, the starter shall include an Emergency Shutdown input which will disable the starter from operating in either Hand or Auto mode regardless of other inputs either manual or auto.
- J. Manufacturer shall provide and install tags with engraved white lettering to designate equipment served

#### 2.04.3 ENCLOSED FULL VOLTAGE NON-REVERSING (FVNR) COMBINATION STARTER

- A. Enclosed combination starters shall include all of the magnetic starter requirements in addition to a disconnecting method. Acceptable disconnects include: motor circuit protectors, UL 489 circuit breakers, or a fused disconnects. All disconnects shall include a lock-out mechanism when in the off position.
- B. The Motor Circuit protector shall be a UL listed 508 current limiting manual motor starter with magnetic trip elements only. The breaker shall carry a UL 508F rating (up to 100A frame size) which provides for coordinated short circuit rating for use with the motor contactor and provides a minimum interrupting rating of 30,000 AIC for the combination starter.
- C. Fused disconnect shall be UL 98 suitable for service entrance protection. It shall accommodate time delay J-style fuses.
- D. UL 489 breaker shall include thermal and magnetic trip mechanisms.

### PART 3 - EXECUTION

3.01 All equipment shall be installed in accordance with the manufacturers' recommendations and printed installation instructions.

3.02 All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Contractors' price shall include all items required as per manufacturers' requirements.

#### 3.03 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet or moisture damaged.

#### 3.04 INSTALLATION

- A. Install wall mounted enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural steel channels bolted to the wall. For controllers not at walls, provide freestanding racks of lightweight structural steel channels bolted to the floor.
- B. Install fuses in each fusible-switch enclosed controller.

- C. Install fuses in control circuits if not factory installed.
- D. Install heater in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- F. Comply with NECA 1.
- G. Install in a professional manner. Any part or parts not meeting this requirement shall be replaced or rebuilt without extra expense to Owner.
- H. Install rotating equipment in static and dynamic balance.
- I. Provide foundations, supports, and isolators properly adjusted to allow minimum vibration transmission within the building.
- J. Correct objectionable noise or vibration transmission in order to operate equipment satisfactorily as determined by the Engineer.

### 3.05 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 16075 "Electrical Identification".
  - 1. Label each enclosure with an engraved nameplate.

### 3.06 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices and facility's central control system. Comply with requirements in Section 16123 "Wire and Cables".
- B. All controls wiring shall be installed in conduit in compliance with Section 16136 "Raceways".
- C. Bundle, train, and support wiring in enclosures.
- D. Connect selector switches and other automatic-control selection devices where applicable.
  - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
  - 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.07 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cool down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA

Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect/Engineer before increasing settings.

- D. Set the taps on reduced-voltage autotransformer controllers at 65 percent.
- E. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.
- F. Set field-adjustable circuit-breaker trip ranges.

**End of Section**

## SECTION 15190

### SYSTEM IDENTIFICATION AND PIPE MARKING

#### PART 1 - GENERAL

##### 1.01 GENERAL REQUIREMENTS

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 15050, are included as a part of this Section as though written in full in this document.

##### 1.02 SCOPE

Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

##### 1.03 Refer to Architectural Sections for additional requirements.

#### PART 2 - PRODUCTS

##### 2.01 VALVE AND PIPE IDENTIFICATION

###### A. Valves:

- 1. All valves shall be identified with a 1-1/2" diameter brass disc wired onto the handle. The disc shall be stamped with 1/2" high depressed black filled identifying numbers. These numbers shall be numerically sequenced for all valves on the job.
- 2. The number and description indicating make, size, model number and service of each valve shall be listed in proper operational sequence, properly typewritten. Three copies to be turned over to Owner at completion.
- 3. Tags shall be fastened with approved meter seal and 4 ply 0.018 smooth copper wire. Tags and fastenings shall be manufactured by the Seton Name Plate Company or approved equal.
- 4. All valves shall be numbered serially with all valves of any one system and/or trade grouped together.

###### B. Pipe Marking:

- 1. All interior visible piping located in accessible spaces such as above accessible ceilings, equipment rooms, attic space, under floor spaces, etc., shall be identified with all temperature pipe markers as manufactured by W.H. Brady Company, 431 West Rock Ave., New Haven, Connecticut, or approved equal.
- 2. All exterior visible piping shall be identified with UV and acid resistant outdoor grade acrylic plastic markers as manufactured by Set Mark distributed by Seton Nameplate Company. Factory location 20 Thompson Road, Branford, Connecticut, or approved equal.
- 3. Generally, markers shall be located on each side of each partition, on each side

of each tee, on each side of each valve and/or valve group, on each side of each piece of equipment, and, for straight runs, at equally spaced intervals not to exceed 75 feet. In congested area, marks shall be placed on each pipe at the points where it enters and leaves the area and at the point of connection of each piece of equipment and automatic control valve. All markers shall have directional arrows.

4. Markers shall be installed after final painting of all piping and equipment and in such a manner that they are visible from the normal maintenance position. Manufacturer's installation instructions shall be closely followed.
5. Markers shall be colored as indicated below per ANSI/OSHA Standards:

<u>SYSTEM</u>	<u>COLOR</u>	<u>LEGEND</u>
Sanitary Sewer	Green	Vent Sanitary Sewer
Storm Drain	Green	Storm Drain
Domestic Water	Green	Domestic Water
Domestic Hot Water Supply	Yellow	Domestic Hot Water Supply
Domestic Hot Water Re-circulating	Yellow	Domestic Hot Water Return
Fire Protection	Red	Fire Protection
Automatic Sprinkler	Red	Fire Sprinkler
Gas	Yellow	Natural Gas
Compressed Air	Blue	Compressed Air

C. CEILING TACKS:

Manufacturers:

1. Brady.
2. Other acceptable manufacturers offering equivalent products.
  - a) LEM.
  - b) Seton.

Description: Steel with 3/4 inch (20 mm) diameter color coded head.

Color code as follows:

1. Yellow - HVAC equipment
2. Red - Fire dampers/smoke dampers
3. Green - Plumbing valves
4. Blue - Heating/cooling valves

### PART 3 - EXECUTION

3.01 All labeling equipment shall be installed as per manufacturers printed installation instructions.

3.02 All items required for a complete and proper installation are not necessarily indicated on the plans



or in the specifications. Contractor's price shall include all items required as per manufacturers' requirements.

- 3.03 All piping shall be cleaned of rust, dirt, oil and all other contaminants prior to painting. Install primer and a quality latex paint over all surfaces of pipe.
- 3.04 Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

**END OF SECTION**

## **SECTION 15240**

### **SOUND AND VIBRATION CONTROL**

#### **PART 1 - GENERAL**

##### **1.01 WORK INCLUDED**

- A. Vibration and sound control products.

##### **1.02 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract including General and Supplementary Conditions and Division One specification sections, apply to work of this section
- B. This section is Division-15 Basic Materials and Methods section, and is part of each Division-15 section making reference to vibration control products specified herein.

##### **1.03 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration control products, of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Vibration and sound control products shall conform to ASHRAE criteria for average noise criteria curves for all equipment at full load conditions.
- C. Except as otherwise indicated, sound and vibration control products shall be provided by a single manufacturer.

##### **1.04 SUBMITTALS**

- A. SHOP DRAWINGS: Indicate size, material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.
- B. PRODUCT DATA: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, and accessories.

#### **PART 2 - PRODUCTS**

##### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Amber/Booth Company, Inc.
- B. Mason Industries, Inc.
- C. Noise Control, Inc.

##### **2.02 GENERAL**

- A. Provide vibration isolation supports for equipment, piping and ductwork, to prevent transmission of vibration and noise to the building structures that may cause discomfort to the occupants.

- B. Model numbers of Amber/Booth products are included for identification. Products of the additional manufacturers will be acceptable provided they comply with all of the requirements of this specification.

#### 2.03 FLOOR MOUNTED AIR HANDLING UNITS

- A. Provide Amber/Booth XLW-2, style C aluminum housed isolators sized for 2" static deflection. Cast iron or steel housings may be used provided they are hot-dip galvanized after fabrication
- B. If floor mounted air handling units are furnished with internal vibration isolation option, provide 2" thick Amber/Booth type NRC ribbed neoprene pads to address high frequency breakout and afford additional unit elevation for condensate drains. Ribbed neoprene pads shall be located in accordance with the air handling unit manufacturer's recommendations.

#### 2.04 SUSPENDED AIR HANDLING UNITS

- A. Provide Amber/Booth type BSWR-2 combination spring and rubber-in-shear isolation hanger sized for 2" static deflection.
- B. If suspended air handling units are furnished with internal vibration isolation option, furnish Amber/Booth type BRD rubber-in-shear or NR AMPAD 3/8" thick neoprene pad isolation hangers sized for approximately 1/2" deflection to address high frequency break-out.

#### 2.05 SUSPENDED FANS AND FAN COIL UNITS

- A. Provide Amber/Booth type BSS spring hangers sized for 1" static deflection.

#### 2.06 PIPING

- A. Provide spring and rubber-in-shear hangers, Amber/Booth type BSR in mechanical equipment rooms, for a minimum distance of 50 feet from isolated equipment for all chilled water and hot water piping 1-1/2" diameter and larger. Springs shall be sized for 1" deflection.
- B. Floor supported piping is required to be isolated with Amber/Booth type SW-1 open springs sized for 1" deflection.
- C. Furnish line size flexible connectors at supply and return of pumps.

#### 2.07 CORROSION PROTECTION

- A. All vibration isolators shall be designed and treated for resistance to corrosion.
- B. Steel components: PVC coated or phosphated and painted with industrial grade enamel. Nuts, bolts, and washers: zinc-electroplated.

### PART 3 - EXECUTION

- 3.01 All equipment shall be installed in accordance with the manufacturer's recommendations and printed installation instructions.
- 3.02 All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturers requirements.
- 3.03 If internal isolation option is used on air handling units, the mechanical contractor shall verify proper adjustment and operation of isolators prior to start-up. All shipping brackets and temporary restraint devices shall be removed.
- 3.04 The vibration isolation supplier shall certify in writing that he has inspected the installation and that all external isolation materials and devices are installed correctly and functioning properly.

**END OF SECTION**

## **SECTION 15260**

### **PIPING INSULATION**

#### **PART 1 - GENERAL**

##### **1.01 GENERAL REQUIREMENTS**

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 15050, are included as a part of this Section as though written in full in this document.

##### **1.02 SCOPE**

- A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.
- B. Work specified elsewhere.
  - 1. Painting.
  - 2. Pipe hangers and supports.
- C. All pipes subject to freezing conditions shall be insulated.

##### **1.03 WARRANTY**

- A. Warrant the Work specified herein for one year against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials or workmanship.
- B. Defects shall include, but not be limited to, the following:
  - 1. Mildewing.
  - 2. Peeling, cracking, and blistering.
  - 3. Condensation on exterior surfaces.

##### **1.04 SUBMITTALS**

- A. SHOP DRAWINGS: Indicate size, material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.
- B. PRODUCT DATA: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, project variations, and accessories.

##### **1.05 DELIVERY AND STORAGE**

- A. DELIVERY: Deliver undamaged materials in the manufacturer's unopened containers. Containers shall be clearly labeled with the insulation's flame and smoke ratings.

#### **PART 2 - PRODUCTS**

- 2.01 It is the intent of these specifications to secure superior quality workmanship resulting in an absolutely satisfactory installation of insulation from the standpoint of both function and appearance. Particular attention shall be given to valves, fittings, pumps, etc., requiring low

temperature insulation to insure full thickness of insulation and proper application of the vapor seal. All flaps of vapor barrier jackets and/or canvas covering must be neatly and securely smoothed and sealed down.

- 2.02 The type of insulation and its installation shall be in strict accordance with these specifications for each service, and the application technique shall be as recommended by the manufacturer. All insulation types, together with adhesives and finishes shall be submitted and approved prior to installation.
- 2.03 A sample quantity of each type of insulation and each type application shall be installed and approval secured prior to proceeding with the main body of the work. Condensation caused by improper installation of insulation shall be corrected by Installing Contractor. Any damage caused by condensation shall be made good at no cost to the Owner or Architect/Engineer.
- 2.04 All insulation shall have composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to insulation) fire and smoke hazard as tested by Procedure ASTM E084, NFPA 255 and UL 723 not exceeding:

Flame Spread 25  
Smoke Developed 50

- 2.05 Accessories, such as adhesives, mastics and cements shall have the same component ratings as listed above.
- 2.06 All products or their shipping cartons shall have a label affixed, indicating flame and smoke ratings do not exceed the above requirements.

#### 2.07 APPROVED MANUFACTURERS

- A. Calcium silicate materials shall be as manufactured by Johns Manville.
- B. Glass fiber materials shall be as manufactured by Johns Manville or Owens-Corning and shall have the same thermal properties, density, fire rating, vapor barrier, etc., as the types specified herein, subject to review by the Engineer.
- C. Adhesives shall be as manufactured by Childers, Foster, HB Fuller or Armstrong, and shall have the same adhesive properties, fire rating, vapor seal, etc., as the types specified herein, subject to review by the Engineer.
- D. Armaflex elastomeric cellular thermal insulation by Armstrong.
- E. Phenolic foam insulation shall be as manufactured by Insul-Phen Insulation (Insul-Phen).
- F. Polyisocyanurate insulation shall be as manufactured by Dow "Trymer 2000 XP".
- G. Metal jacketing and fitting covers shall be as manufactured by Childers or RPR Products.

#### 2.08 MATERIALS

- A. For insulation purpose piping is defined as the complete piping system including supplies and returns, pipes, valves, automatic control valve bodies, fittings, flanges, strainers, thermometer well, unions, reducing stations, and orifice assemblies.
- B. INTERIOR DOMESTIC WATER PIPE: provide fiberglass pipe insulation with all service jackets with self sealing lap joint.

- C. EXTERIOR DOMESTIC WATER PIPE: Provide elastomeric cellular thermal, or preformed phenolic foam pipe insulation with secured metal jacketing.
- D. DRAIN BODIES AND DOWN SPOUTS: Insulate horizontal roof drain down spouts, underside of roof drain bodies, chilled water waste lines from drinking fountain to junction with main waste stacks, and branch lines including traps and exposed underside of floor drains receiving cooling coil condensate, same as water piping where exposed to building occupant view. When concealed, insulation may be same as specified for external duct wrap.
- E. CONDENSATE DRAINAGE PIPING: Fire resistant fiberglass insulation; insulation not required when piping is exposed on roof.
- F. REFRIGERANT PIPING: Refrigerant pipe insulation shall be model "AP-2000", fire rated for use in environmental air plenums. Apply manufacturers recommended finish and sealant for exterior applications.
- G. METAL JACKETING: Utilize Childers "Strap-On" jacketing. Provide preformed fitting covers for all elbows and tees.

### PART 3 - EXECUTION

- 3.01 All insulation shall be installed in accordance with the manufacturers' recommendations and printed installation instructions, including high density inserts at all hangers and pipe supports to prevent compression of insulation.
- 3.02 All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturers requirements.
- 3.03 Pipes located outdoors or in tunnels shall be insulated same as concealed piping; and in addition shall have a jacket of 0.016 inch thick, smooth aluminum with longitudinal modified Pittsburgh Z-Lock seam and 2 inch overlap. Jacketing shall be easily removed and replaced without damage. All butt joints shall be sealed with gray silicone. Galvanized banding is not acceptable.
- 3.04 All insulated piping located over driveways shall have an aluminum shield permanently banded over insulation to protect it from damage from car antennas.
- 3.05 WATER PIPE INSULATION INSTALLATION
  - A. The insulation shall be applied to clean, dry pipes with all joints firmly butted together. Where piping is interrupted by fittings, flanges, valves or hangers and at intervals not to exceed 25 feet on straight runs, an isolating seal shall be formed between the vapor barrier jacket and the bare pipe. The seal shall be by the applications of adhesive to the exposed insulation joint faces, carried continuously down to and along 4 inches of pipe and up to and along 2 inches of jacket.
  - B. Pipe fittings and valves shall be insulated with pre-molded or shop fabricated glass fiber covers finished with two brush coats of vapor barrier mastic reinforced with glass fabric.
  - C. All under lap surfaces shall be clean and free of dust, etc. before the SSL is sealed. These laps shall be firmly rubbed to insure a positive seal. A brush coat of vapor retarder shall be applied to all edges of the vapor barrier jacket.
- 3.06 FIRE RATED INSULATION

- A. All pipe penetrations through walls and concrete floors shall be fire rated by applying USG Thermafiber in the space between the concrete and the pipe.
- B. The fire rating shall be additionally sealed by using 3M brand model CP 25 or 303 fire barrier caulk and putty.
- C. All fire rating material shall be insulated in accordance with manufacturer's printed instructions.

#### PART 4 - SCHEDULES

4.01	LOW TEMPERATURE SURFACES	MINIMUM INSULATION THICKNESS BASED ON FIBERGLASS
A.	Exposed exterior domestic water pipe:	1½ inch
B.	Interior domestic cold water pipe exposed to freezing temperatures (apparatus bay):	1 inch
C.	Condensate drain lines:	¾ inch
D.	Drains receiving condensate:	1 inch
E.	Concealed horizontal leader from roof drain:	1½ inch blanket wrap
	Exposed horizontal leader from roof drain:	1 inch thick rigid with all service jackets
F.	Refrigerant Piping	
	(1) 1" and smaller	1 inch
	(2) Larger than 1½ inch	1½ inch
4.02	HIGH TEMPERATURE SURFACES	MINIMUM INSULATION THICKNESS
A.	Domestic Hot Water and Hot Water Circulating Piping	1 inch

**END OF SECTION**



**SECTION 15290**  
**DUCT INSULATION**

**PART 1 - GENERAL**

**1.01 WORK INCLUDED**

- A. Ductwork system insulation.

**1.02 RELATED SECTIONS**

- A. Section 15050 - Basic Materials and Methods
- B. Section 15170 - Motors and Motor Controllers
- C. Section 15190 - System Identification and Pipe Marking

**1.03 QUALITY ASSURANCE**

- A. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.
- B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.
  - 1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.
- C. Duct and plenum insulation shall comply with minimum R-value requirements of 2012 International Energy Conservation Code.
- D. Adhesive and other material shall comply with NFPA and NBFU Standards No. 90A and 90B.

**1.04 SUBMITTALS**

- A. SHOP DRAWINGS: Indicate size, material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.
- B. PRODUCT DATA: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, and accessories. Provide 8x11 sample of product along with submittal.

**1.05 DELIVERY, STORAGE AND HANDLING**

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in unopened containers with manufacturer's stamp, clearly labeled with flame and smoke rating, affixed showing fire hazard indexes of products.
- B. Protect insulation against dirt, water and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

## PART 2 - PRODUCTS

### 2.01 GENERAL DESCRIPTION

- A. The type of insulation and its installation shall be in strict accordance with these specifications for each service, and the application technique shall be as recommended by the manufacturer. All insulation types, together with adhesives and finishes shall be submitted and approved before any insulation is installed.
- B. A sample quantity of each type of insulation and each type of application shall be installed and approval secured prior to proceeding with the main body of the work.

### 2.02 ACCEPTABLE MANUFACTURERS

- A. Glass fiber materials shall be as manufactured by Knauf, Certain-Teed, Johns-Manville or Owens-Corning and shall have the same thermal properties, density, fire rating, vapor barrier, etc., as the types specified herein, subject to review by the Engineer.
- B. Adhesives shall be as manufactured by Minnesota Mining, Arabol, Benjamin-Foster, Armstrong or Insulmastic, Inc., and shall have the same adhesive properties, fire rating, vapor seal, etc., as the types specified herein, subject to review by the Engineer.
- C. Ceramic fiber materials shall be as manufactured by Primer Refractories, A.P. Green Refractories or approved equal.

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. All insulation shall be installed in accordance with the manufacturer's recommendations and printed installation instructions.
- B. All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturer's requirements.

### 3.02 EXTERNAL DUCT INSULATION

- A. Fasten all longitudinal and circumferential laps with outward clinching staples 3" on center. On rectangular ducts over 24" wide apply as above and hold insulation in place on bottom side with mechanical pins and clips on 12" centers.
- B. Seal all joints, fastener penetrations and other breaks in vapor barrier with 3 inch wide strips of white glass fabric embedded between two coats of vapor barrier mastic, Childers CP-30 or approved equal. Contractor may choose to seal all joints, fastener penetrations and other breaks in vapor barrier with 3 inch wide strips of aluminum foil tape. Duct tape shall be UL listed 181 A-P/B-FX and UL 723. Shurtape No. AF-982 or approved equivalent.
- C. All external duct insulation shall be Johns Manville Type 75 fiberglass duct wrap insulation with reinforced aluminum facing or approved equal.
- D. External duct wrap is required on all outside air ducts, return ducts, and supply air ducts that are not internally insulated. Duct wrap shall be provided as follows:

1. A minimum installed R-value of 6 when ducts are located in unconditioned spaces, such as ceiling plenum space.
2. A minimum installed R-value of 8 when ducts are located outside of the building.

### 3.03 DUCT LINER

- A. Duct liner shall be kept clean and dry during transportation, storage and installation. Care should be taken to protect the liner from exposure to the elements or damage from mechanical abuse.
- B. All portions of duct designed to receive duct liner shall be completely covered with liner as specified. The smooth, black, acrylic-coated surfaces with flexible glass cloth reinforcement shall face the airstream. All duct liner shall be cut to assure tight, overlapped corner joints. The top pieces shall be supported by the sidepieces. Duct liner shall be installed following the guidelines in the NAIMA "Duct Liner Installation Standard".
- C. The duct liner shall be tested according to erosion test method in UL 181 and shall be guaranteed to withstand velocities in the duct system up to 5000 fpm without surface erosion.
- D. Duct liner shall be adhered to the sheet metal with full coverage of an approved adhesive that conforms to ASTM C 916, and all exposed leading edges and transverse joints shall be coated with Permacote factory-applied or field-applied edge coating and shall be neatly butted without gaps. Shop or field cuts shall be liberally coated with Johns Manville SuperSeal® duct butter and Edge Treatment or approved adhesive.
- E. Metal nosings shall be securely installed over transversely oriented liner edges facing the airstream at forward discharge and at any point where lined duct is preceded by unlined duct.
- F. When velocity exceeds 4000 fpm (20.3 m/sec), use metal nosing on every leading edge. Nosing may be formed on duct or be channel or zee attached by screws, rivets or welds.
- G. The liner shall further be secured with Graham welding pins and washers on not more than 18 inch centers both vertical and horizontal surfaces, and the pins and washers shall be pointed up with adhesive.
- H. Duct liner shall be Johns Manville Linacoustic RC fiberglass duct liner with factory-applied edge coating or approved equal. The liner shall meet the Life Safety Standards as established by NFPA 90A and 90B, FHC 25/50 and Limited Combustibility and the air stream surface coating should contain an immobilized, EPA-registered, anti microbial agent so it will not support microbial growth as tested in accordance with ASTM G21 and G22. The duct liner shall conform to the requirements of ASTM C 1071, with an NRC not less than .70 as tested per ASTM C 423 using a Type "A" mounting, and a thermal conductivity no higher than .25 BTU•in/(hr•ft<sup>2</sup>•°F) at 75°F mean temperature.
- I. Duct liner is required on all return air ductwork, return air boots and supply air ductwork within 15 feet of the air handling units. Provide sheet metal liner cap over all leading edges of internal insulation exposed to air stream. Duct liner shall be provided as follows:
  1. A minimum installed R-value of 6 when ducts are located in unconditioned spaces, such as ceiling plenum space.
  2. A minimum installed R-value of 8 when ducts are located outside of the building.

3.04 EXPOSED DUCTWORK LOCATED INDOORS

- A. Round duct routed exposed shall be double wall with solid inner liner and 1-1/2" thick layer of fiberglass insulation as manufactured by United McGill Company model no. Acousti-27 or approved equal.

3.05 EXPOSED DUCT LOCATED OUTDOORS

- A. All duct located outdoors shall be internally lined as specified and also shall have a 2" thick, 6 lb. density rigid board external duct insulation, finished with a white weatherproofed canvas material.

3.06 AIR DEVICE AND MISCELLANEOUS DUCT INSULATION

- A. The backside of all supply air devices shall be insulated with taped and sealed with external duct wrap equivalent to the insulation specified.
- B. The contractor shall install an additional layer of 1½ inch thick external fiberglass duct wrap on any portion of the supply air, return air, outside air, or exhaust air system that has condensation forming during any period of operation. The insulation shall be taped and sealed and located until all evidence of the condensation had been eliminated at no additional cost to the owner.

**END OF SECTION**

## **SECTION 15330**

### **WET PIPE FIRE PROTECTION SPRINKLER SYSTEM**

#### **PART 1 - GENERAL**

##### **1.01 GENERAL REQUIREMENTS**

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 15050, are included as a part of this Section as though written in full in this document.

##### **1.02 SCOPE**

- A. Scope of the work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

##### **1.03 REGULATORY CODES**

- A. Work in accordance with:
  - 1. NFPA.
  - 2. Local municipal codes that have jurisdiction.
- B. Products in accordance with:
  - 1. United Laboratories (UL) listed.
  - 2. Factory Mutual (FM) approved.

##### **1.04 CERTIFICATE OF TESTING**

- A. Furnish Owner with test certificate certifying the system approved by:
  - 1. City Fire Marshall.

#### **PART 2 - PRODUCTS**

##### **2.01 FIRE SPRINKLER SYSTEM**

- A. GENERAL:
  - 1. Work Included:
    - a. Design, coordination and installation of inside and outside piping, including sprinkler heads, valves, hangers and supports sleeves.
    - b. The sprinkler system is a wet type and is designed to provide coverage for entire building. The Contract Drawings indicate the extent and general arrangement, and the various occupancy classifications.
    - c. Sprinkler heads are not shown.
    - d. The plans provide a preliminary layout with riser assembly location, flow switch locations, valve locations, and fire department Siamese connections. These are a guide for subsequent preparation of the Contractor's detailed working drawings.
    - e. Interface system with building fire and smoke alarm system.
  - 2. Quality Assurance: Equipment and installation to meet requirements of NFPA

Number 13, latest edition and local authority having jurisdiction. All components of the completed system shall be UL listed for the intended service.

2.02 SUBMITTALS:

- A. Submit shop drawings in accordance with Section 15050.
- B. Submit preliminary layout showing only head locations for review by Architect/Engineer. Furnish additional heads which may be required for coordinated ceiling pattern without added cost, even though number of heads may exceed minimum code requirements.
- C. Submit shop drawings of entire sprinkler system including hydraulic calculations to Architect/Engineer.
- D. Provide Architect with six complete sets of final approved shop drawings before starting the installation. Include details of the sprinkler system showing sections, light fixtures, air conditioning, ducts, and a plan giving fire department connections, location of all exposed structures within twenty feet of this structure, and other equipment to be used. Drawings shall bear the stamp of review of the local fire insurance rating organization having jurisdiction.
- E. Service Utility Diagram: Furnish Architect with an accurately marked print showing location of underground pipes and valves as installed upon completion of underground Work.
- F. Provide a printed sheet giving brief instructions relative to all necessary aspects of sprinkler controls and emergency procedures next to sprinkler riser mains. Instruction sheet to be protected by glass or a transparent plastic cover.
- G. Materials:
  - 1. Piping:
    - a. All piping above grade shall be:
      - schedule 10 black steel pipe with a rolled groove ends, joined with mechanical coupling and cut groove cast iron fittings for pipe 2-1/2" and greater.
      - schedule 40 black steel threaded pipe and fittings for pipe 2" and smaller.
    - b. Acceptable manufacturer:
      - American Tube
      - Wheatland Tube
      - Gem Sprinkler
      - All piping shall be by a domestic manufacturer.
    - c. Acceptable mechanical coupling manufacturer:
      - Victaulic
      - Grinnell
  - 2. Sprinkler Heads:
    - a. Suspended Ceiling Type: Concealed pendant type with brass finish and white cover plate.
    - b. Exposed Area Type: Standard upright type with brass finish.
    - c. Sidewall Type: White finish with matching escutcheon.
    - d. Temperature rating on fusible links to suit specific hazard area with minimum margin or safety 50 degrees F. See Table 1 for more information.
    - e. Sprinkler heads of the "O"-ring seal type are not acceptable.
    - f. Acceptable manufacturer:

- Tyco
  - Grinnell
  - Viking
3. Sprinkler Alarm Valve:
    - a. Provide approved automatic sprinkler valve with one or two pole (as required) flow detectors, pressure switch, outside electric gongs, and inside electric gong and circuit breaker.
    - b. Acceptable manufacturer:
      - Tyco
      - Grinnell
      - Viking
  4. Valves:
    - a. 2" and smaller: bronze, rising stem, inside screw, solid wedge, U.L. listed valve.
    - b. 2-1/2" and larger: iron body, bronze trim, rising stem, OS&Y, solid wedge, U.L. listed valve.
    - c. Check valve: cast iron flanged body, bronze fitted, non-slam type.
    - d. Install valves with stems upright or horizontal, not inverted.
    - e. Acceptable manufacturer:
      - Nibco
      - Grinnell
      - Stockham
      - Victaulic
  5. Fire Department Connection:
    - a. Standard wall type or free standing post type, brass finish, thread size to suit fire department hardware; two way threaded dust cap and chain of same material and finish, and 3/4 inch automatic drip and signage marked "Sprinkler – Fire Department Connection".
    - b. Acceptable manufacturer:
      - Potter – Roemer
      - Elkhart Brass
      - Reliable
  6. Insulation:
    - a. All piping and valves exposed to the weather or within building and exposed to the weather shall be insulated with Phenolic foam with ASJ and all joints sealed. Insulation density shall not be less than 1.5 pounds per cubic foot, and conductivity (K) not higher than 0.25 and 75°F mean temperature difference, with factory applied all weather vapor barrier jacket.
    - b. All insulated pipe and valves subject to damage shall be protected with an aluminum jacket with sealed joints.
    - c. Refer to section 15260 for detailed specification.

### PART 3 - EXECUTION

- 3.01 All equipment shall be installed in accordance with the manufacturer's recommendations and printed installation instructions.
- 3.02 All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items as required by NFPA and installed as per manufacturer's recommendations.
- 3.03 DESIGN
  - A. Design spacing of sprinkler heads and selection sizes shall conform to the requirement of

NFPA 13 for the indicated occupancy.

- B. Uniform discharge density design shall be based on hydraulic calculations utilizing the method outlined in NFPA 13. Density of discharge from sprinkler heads shall conform with NFPA 13.
- C. Friction losses in pipe will be based on a value of "C" =120 in the Hazen - Williams formula.
- D. Design and install the system so that no part will interfere with doors, windows, heating, plumbing, or electrical equipment. Do not locate sprinkler heads within 6 inches of lighting fixtures, HVAC diffusers and other obstructions. Sprinkler piping cannot penetrate ductwork or lighting fixtures.
- E. The Contractor shall conform to the National Fire Protection Association's Fire Code No. 13, latest edition. Special attention shall be given to Article 1-9, working plans. It shall be the Contractor's responsibility to determine if any deficiency or deviations, such as an inadequate water supply, or any other item which would materially affect the acceptability of the system.

#### 3.04 INSTALLATION

- A. Install all items in accordance with applicable codes.
- B. Install piping so that mains and branches are not located directly underneath HVAC equipment or other items needing access.
- C. All sprinkler heads shall be located as near the center of ceiling tiles as is practical ( $\pm 1/2"$ ). Location shall present a uniform pattern with all heads aligned when completely installed.
- D. Run piping concealed above furred ceilings and in joists to minimize obstructions. Expose only heads. Exact routing of piping shall be approved by Architect or relocated as required at no additional cost to Owner.
- E. Protect sprinkler heads against mechanical injury with standard guards.
- F. Locate outside alarms on wall of building adjacent to siamese fire department connection.
- G. Provide on wall near sprinkler valve, cabinet containing four extra sprinkler heads of each type and wrench suitable for each head type.
- H. Provide 1 inch diameter nipple and 1 inch x 1/2 inch reducing fitting for each upright head.
- I. Painting shall be as follows:
  - 1. Exposed sprinkler riser, alarm valve and all related piping shall be painted red.
  - 2. Exposed sprinkler piping in finished areas shall be painted as directed by Architect.

#### 3.05 REPLACEMENT

Upon receipt of written notice of failure of any part of the guaranteed equipment during the guaranteed period, the Contractor will replace the affected part or parts promptly at no additional cost.



### 3.06 TESTING

- A. Prior to testing, the entire sprinkler system shall be thoroughly flushed clean.
- B. Upon completion of the installation and flushing, test the system and obtain approval of the local fire insurance rating organization having jurisdiction. Particular attention is called to the requirements of NFPA 13 pamphlet.

### 3.07 TRAINING

- A. Owner's people shall be fully briefed in the normal start-up of the system, operation, normal and emergency shutdown, and maintenance of the system.
- B. Routine maintenance, yearly maintenance, winterization, and spring start-up shall be fully discussed and documented.
- C. Names of those instructed and dates, as well as a list of information handed over to the owner, shall be included in the final report.

### END OF SECTION

Table 1 Initial sprinkler head schedule					
ID	Type	K-factor	Sprinkler Temperat ure Rating (°F)	Orifice (in)	Areas of Use
A	Concealed (QR)	5.6	135-170	1/2	High-finish areas
B	Recessed pendent (QR)	5.6	135-170	1/2	Common areas
C	Upright/Pendent (QR)	5.6	135-170	1/2	Open ceiling areas
D	Extended coverage (ECQR)	5.6	135-170	1/2	Large, open work areas
E	Upright/Pendent (QR)	5.6	175-225	1/2	Mech/elec/LAN rooms
F	Dry pendent (QR)	5.6	135-170	1/2	Server rooms
G	Storage or possibly ESFR	11.2 or 14	135-170	3/4	Warehouse
H	Dry sidewall (QR)	5.6	135-170	1/2	Loading dock

## **SECTION 15410**

### **PLUMBING PIPING AND VALVES**

#### **PART 1 - GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Pipe and pipe fittings.
- B. Valves.
- C. Sanitary sewer piping system.
- D. Storm water piping system.
- E. Domestic water piping system.
- F. Compressed air piping system.

##### **1.02 RELATED SECTIONS**

- A. Section 02222 - Excavating.
- B. Section 02223 - Backfilling.
- C. Section 02225 - Trenching.
- D. Section 15140 - Supports and Anchors.
- E. Section 15190 - Mechanical Identification.
- F. Section 15242 - Vibration Isolation.
- G. Section 15260 - Piping Insulation.
- H. Section 15430 - Plumbing Specialties.
- I. Section 15440 - Plumbing Fixtures.
- J. Section 15450 - Plumbing Equipment.

##### **1.03 REFERENCES**

- A. ANSI B31.1 - Power Piping.
- B. ANSI B31.9 - Building Service Piping.
- C. ASME - Boiler and Pressure Vessel Code.
- D. ASME Sec. 9 - Welding and Brazing Qualifications.
- E. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800.
- F. ASME B16.3 - Malleable Iron Threaded Fittings.

- G. ASME B16.4 - Cast Iron Threaded Fittings Class 125 and 250.
- H. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings
- I. ASTM A47 - Ferritic Malleable Iron Castings.
- J. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- K. ASTM A74 - Cast Iron Soil Pipe and Fittings.
- L. ASTM B32 - Solder Metal.
- M. ASTM B42 - Seamless Copper Pipe.
- N. ASTM B306 - Copper Drainage Tube (DWV).
- O. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, 80, and 120.
- P. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).
- Q. ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- R. ASTM D2564 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
- S. ASTM D2729 - Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- T. ASTM D2846 - Chlorinated Polyvinyl Chloride (CPVC) Pipe, Fittings, Solvent Cements and Adhesives for Potable Hot Water Systems.
- U. ASTM F493 - Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
- V. AWWA C111- Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings.
- W. AWWA C651 - Disinfecting Water Mains.
- X. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
- Y. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.

#### 1.04 SUBMITTALS

- A. Submit under provisions of Division One.
- B. Product Data: Provide data on pipe materials, Pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

#### 1.05 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division One.
- B. Record actual locations of valves.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division One.
- B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.07 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating cast or marked on valve body.
- B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.
- C. Welders Certification: In accordance with ASME Sec 9.
- D. Foreign pipe, fittings or valves are unacceptable.
- E. Piping shall be labeled along entire length indicating size, class, material specification, manufacturers name and country of origin.

1.08 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 5 years documented experience and must be a domestic manufacturer.
- B. Installer: Company specializing in performing the work of this section with minimum 5 years documented experience.

1.09 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with plumbing and building codes having jurisdiction.
- B. Conform to applicable codes for the provision and installation of all required backflow prevention devices.
- C. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.
- D. No PVC pipe or fittings will be allowed for any areas where pipe is to penetrate a fire rated assembly or to be installed in a return air plenum unless the entire length of all such piping is encased within a minimum 2 hour fire rated enclosure.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division One.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system. Tape will not be allowed as an acceptable end cover.

#### 1.11 EXTRA MATERIALS

- A. Furnish under provisions of Division One.
- B. Provide two repacking kits for each size valve.

### PART 2 - PRODUCTS

#### 2.01 SANITARY SOIL WASTE AND VENT PIPING, BURIED BEYOND 5 FEET OUTSIDE OF BUILDING

- A. PVC Pipe: ASTM D 1785/D 2729 schedule 40; installed per ASTM D 2321.
  - 1. Fittings: PVC, ASTM D 3311/D 2665 drainage pattern, with bell and spigot ends. Furnished by the same manufacturer as pipe or approved equal.
  - 2. Joints: solvent weld with ASTM D 2564 solvent cement, installed per the requirements of ASTM D 2855.

\*\*\*OR\*\*\*

- B. PVC pipe: ASTM D 3034, SDR 35; installed per ASTM D 2321.
  - 1. Fittings: ASTM F 1336 PVC, drainage pattern, with bell and spigot ends. Furnished by the same manufacturer as pipe or approved equal.
  - 2. Joints: ASTM F 477 or F 913, elastomeric gaskets or solvent weld.

#### 2.02 SANITARY SOIL, WASTE AND VENT PIPING, BURIED WITHIN 5 FEET OF BUILDING, BELOW GRADE

- A. PVC Pipe: ASTM D 1785/D 2665 schedule 40
  - 1. Fittings: PVC, ASTM D 3311/D 2665 drainage pattern, with bell and spigot ends to be furnished by the same manufacturer as pipe or approved equal.
  - 2. Joints: solvent weld with ASTM D 2564 solvent cement, clear, medium bodied, for sizes 3" and smaller and gray, heavy bodied, for sizes 4" and larger, mating surfaces shall be prepared with ASTM F 656 purple primer immediately prior to cement application.

#### 2.03 SANITARY SOIL, WASTE AND VENT PIPING, WITHIN BUILDING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A 888, hubless, service weight.
  - 1. Fittings: Cast iron, ASTM A 888 drainage pattern.
  - 2. Joints: No hub, ASTM C 564 neoprene gaskets and standard stainless steel clamp and solid shield assemblies constructed of type 300 series stainless steel. Clamp assemblies shall conform to FM 1680 where required by the administrative authority.
- B. Copper Tubing: ASTM B 306, DWV, sizes 2" and smaller.
  - 1. Fittings: ASME B 16.23 cast bronze, or ASME B16.29, wrought copper.
  - 2. Joints: ASTM B 32, solder, Grade 50B.

- C. Brass Pipe: ASTM B 43, chrome plated.
  - 1. Fittings: ASME B 16.23 cast bronze, chrome plated.
  - 2. Joints: ASTM B 32, solder, Grade 50B.
- D. Steel Pipe: ASTM A 53, Schedule 40, galvanized, sizes 2-1/2" and smaller, for waste and vent piping only, steel soil pipes not permitted.
  - 1. Fittings: Malleable iron, galvanized.
  - 2. Joints: ASME B16.3 screwed.
- 2.04 STORM WATER PIPING, BURIED BEYOND 5 FEET OUTSIDE OF BUILDING
  - A. Pipe and fittings shall be same as specified for sanitary piping system.
- 2.05 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING, BELOW GRADE
  - A. Pipe and fittings shall be same as specified for sanitary soil, waste and vent piping system.
- 2.06 STORM WATER PIPING, WITHIN BUILDING, ABOVE GRADE
  - A. Cast Iron Pipe: ASTM A 74 service weight.
    - 1. Fittings: Cast iron, ASTM A 74 drainage pattern.
    - 2. Joints: Hub and spigot, ASTM C 564 neoprene, compression type gaskets.
- 2.07 DOMESTIC WATER PIPING, BURIED BEYOND 5 FEET OUTSIDE OF BUILDING
  - A. PVC Pipe: AWWA C900 CLASS 150.
    - 1. Fittings: Ductile or gray cast iron, standard thickness.
    - 2. Joints: ANSI/AWWA C111, rubber gasket with 3/4 inch diameter rods.
  - B. PVC Pipe: ASTM D 1785 schedule 80.
    - 1. Fittings: ASTM D 2467 PVC.
    - 2. Joints: ASTM D 2855, solvent weld with ASTM D 2564 solvent cement.
- 2.08 DOMESTIC WATER PIPE, BURIED WITHIN 5 FEET OF BUILDING, BELOW GRADE
  - A. Copper Tubing: ASTM B 88, Type K, soft annealed.
    - 1. Fittings: ASME B 16.18, cast bronze, ASTM B 16.22 wrought copper alloy or ASTM B 16.26 cast bronze for flared fittings.
    - 2. Joints: Sweat solder or flared. Note: No joints will be permitted in pressure water pipe below slab on grade. All such piping must be brought up above finished floor line a minimum of 12" before joining. Exception may be taken when pipe is fully enclosed in pressure rated sleeve and pre-approved by the Architect and Engineer.
- 2.09 DOMESTIC WATER PIPING, WITHIN BUILDING, ABOVE GRADE
  - A. Copper Tubing: ASTM B 88, Type L, hard drawn.

1. Fittings: ASME B 16.18, cast bronze, or ASTM B 16.22 wrought copper alloy.
2. Joints: ASTM B 32, solder.

## 2.10 COMPRESSED AIR PIPING SYSTEM

### A. Steel Pipe: ASTM A 53, Schedule 40, galvanized.

1. Fittings: ANSI B 16.3 Malleable iron, 150 lb. galvanized.
2. Joints: Screwed for sizes less than 4", flanged or mechanical cut grooved couplings for sizes 4" and larger.

## 2.11 FLANGES AND UNIONS

### A. Pipe size 2 inches and under:

1. Ferrous pipe: ANSI B16.39, 150 psig malleable iron threaded unions.
2. Copper tube and pipe: 150 psig bronze unions with soldered ends.
3. Ferrous pipe: ANSI B16.5, 150 psig forged steel flanges; screwed neck, 1/16" thick preformed neoprene gaskets.

### B. Pipe size 2-1/2 inches and larger:

1. Ferrous pipe: 150 psig forged steel slip-on flanges; weld neck, 1/16" thick preformed neoprene gaskets.
2. Copper tube and pipe: 150 psig slip-on bronze flanges; 1/16" thick preformed neoprene gaskets.

### C. Dielectric Connections:

1. Pipe size 2 inches and under: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
2. Pipe size 2-1/2 inch and larger: flange, connection as above, with water impervious isolation barrier.

## 2.12 GATE VALVES

### A. Manufacturers:

1. Nibco No. T-111 up to 2-1/2"; F-617-O 3" and over.
2. Other acceptable manufacturers offering equivalent products.
  - a. Crane No. 428 up to 2-1/2"; 465-1/2 3" and over.
  - b. Stockham No. B-100 up to 2-1/2"; G-623 3" and over.
  - c. Grinnell No. 3010 up to 2-1/2"; 6020A 3" and over.

### B. Up to and including 2-1/2" Inches: Bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge threaded ends.

### C. Over 3" Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, solid wedge, flanged ends.

### D. Provide bronze tee or cast iron square nut operator for all valves installed below ground.

1. Valves 2-1/2" and smaller shall be equipped with ASTM B62 solid red bronze tee securely affixed to the valve stem.

2. Valves 3" and larger shall be equipped with a standard 2" square combination nut/socket securely affixed to the valve stem.
3. Provide owner with two extended tee handle operating wrenches for each type of valve head installed.

#### 2.13 BALL VALVES

##### A. Manufacturers:

1. Nibco No. T-585-70-66
2. Other acceptable manufacturers offering equivalent products.
  - a. Crane No. 9303-B
  - b. Stockham Model S-216BR-1R-T
  - c. Grinnell No. 3700-6

B. Up to and including 2 Inches: Bronze two 600 PSI piece body full port, stainless steel ball and stem, Teflon seats and stuffing box ring, lever handle and balancing stops, threaded ends with union.

C. Ball valves used for balancing shall have memory stops.

#### 2.14 SWING CHECK VALVES

##### A. Manufacturers:

1. Nibco No. T-413-B up to 2-1/2"; F-918 3" and over.
2. Other acceptable manufacturers offering equivalent products.
  - a. Crane No. 37 up to 2-1/2"; 372 3" and over.
  - b. Stockham No. B-319; up to 2-1/2"; G931 3" and over.
  - c. Grinnell No. 3300 up to 2-1/2"; 6300A 3" and over.

B. Up to and including 2-1/2 Inches: Bronze swing disc, screwed ends.

C. Over 2-1/2 Inches: Iron body, bronze trim, swing disc, renewable disc and seat, flanged ends. Include outside lever and adjustable weight where required for quiet operation.

#### 2.15 SPRING LOADED (SILENT) CHECK VALVES

##### A. Manufacturers:

1. Nibco No. W-910
2. Other acceptable manufacturers offering equivalent products.
  - a. Grinnell No. 402

B. Iron body, bronze trim, stainless steel spring, renewable composition disc, screwed, wafer, or flanged ends.

#### 2.16 SOLDER

- A. 95.5% tin, 4% copper, 0.5% silver.
- B. Lead free, antimony free, zinc-free.
- C. Silvabrite 100, by Engelhard Corporation or approved equal.



## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Coordinate and verify excavations under provisions of Division Two.
- B. Verify that all excavations are to the required grade, dry, and not over-excavated.

### 3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale, oil and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Install, clean bank sand backfill in trench to a minimum of 6 inches below pipe, and to cover all piping a minimum of 12 inches above pipe.

### 3.03 INSTALLATION

- A. Install all materials in accordance with manufacturer's published instructions.
- B. All exposed sewer and water pipe in toilet rooms or other finished areas of the building shall be chromium plated.
- C. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- D. Route piping in orderly manner, parallel and perpendicular to building column grid lines, unless indicated otherwise on drawings, and maintain gradients.
- E. Install piping to conserve building space and not conflict with other trades or interfere with intended use of space.
- F. Group piping whenever practical at common elevations.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- H. Provide clearance for installation of insulation and access to valves and fittings. Valves installed beyond reasonable reach shall be provided with chain operator.
- I. Provide access doors where valves and operable fittings are not exposed. Access doors shall be of approved types set in locations pre-approved by submittal to the Architect.
- J. Establish elevations of buried piping outside the building to ensure not less than 2 feet of cover, or maximum depth of frost penetration, which ever is the greater.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- L. Provide encasement for and support of utility meters in accordance with requirements of utility companies.

- M. Gate valves installed below grade shall be covered with an adjustable cast iron roadway box extended to grade. Cover shall be cast iron with 'water' cast on top and set flush to finished paving or 2" above finished earthen grade. Box shall be supported from undisturbed soil or concrete base and shall not introduce any stress to piping under all traffic conditions.
- N. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting.
- O. Excavate in accordance with Division Two.
- P. Backfill in accordance with Division Two.
- Q. Install bell and spigot pipe with bell end upstream.
- R. Maintain uniformity in the installation of piping materials and joining methods. Do not mix materials types.
- S. Install valves with stems upright or horizontal, not inverted.
- T. Solder joints shall be wiped clean at each joint, remove excess metal while molten and flux residue when cooled.
- U. No PVC pipe or fittings will be allowed for any areas where pipe is installed in return air plenum unless the entire length of all such piping is encased within a minimum 2 hour fire rated enclosure.
- V. Installations of thermoplastic piping systems shall be in strict conformity to the manufacturers published instructions. Under ground drainage pipe installations shall be in conformity to ASTM D 2321.
- W. Installation of solvent cement joints for PVC piping shall be in strict conformity to the requirements outlined in ASTM D 2855.
- X. Waste nipple from wall to tapped tee shall be schedule 40 threaded galvanized steel pipe or brass or copper with threaded adapter.
- Y. Provide approved PVC slip by cast iron no hub adaptor at each transition from underground PVC piping to above ground cast iron pipe using standard or wide bodied no hub couplings for as specified elsewhere in this section. Transition shall be made as close as possible to floor for sanitary DWV piping systems and at test tee for storm drainage piping. Support vertical cast iron pipe from floor anchors with using riser clamp and galvanized all thread rod as specified in section 15140.

#### 3.04 APPLICATION

- A. Install union downstream of all valves at equipment or apparatus connections.
- B. Install male adapters each side of threaded valves in copper piped system. Sweat solder adapters to tube prior to make-up of threaded connections.
- C. Install gate valves for shut-off and to isolate all equipment items, distinct parts of systems, or vertical risers.
- D. Each plumbing fixture shall have a shut-off valve on each hot water and cold water supply line.

- E. Each plumbing water rough-in stub out shall be fitted with a shut off valve.
- F. Install globe, ball or butterfly valves for throttling, bypass, or balancing (manual flow control) services.
- G. Ball valves installed in insulated piping shall be fitted with extended lever operators of sufficient length to raise handle above the insulation jacket material. Where valve is used for throttling service valve handle shall be equipped with adjustable memory stop device.
- H. Provide spring loaded, non-slam, check valves on discharge of water pumps.

### 3.05 ERECTION TOLERANCES

- A. All drainage lines in the building shall have 1/4 inch to the foot fall where possible and not less than 1/8 inch to the foot fall toward the main sewer. Pipe must be so laid that the slope will be uniform and continuous. Permission shall be secured from the Architect and Engineer before proceeding with any Work where existing conditions prevent the installation at minimum grade specified.
- B. Slope all water piping and arrange to drain at low points. Provide loose key operated, polished chrome, sill cock flush to wall where fixture stop will not suffice for this requirement.

### 3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, all domestic water systems shall be complete, thoroughly flushed clean and free of all foreign matter or erection residue.
- B. Ensure PH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. On building side of the main shut off valve, provide a 3/4" connection through which chlorine can be introduced into the water piping
- D. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, in sufficient quantity to obtain 50 to 80 mg/L residual free chlorine solution throughout the entire domestic water piping systems.
- E. Bleed water from outlets as required to ensure complete distribution and test for disinfectant residual at a minimum 15 percent of total outlets.
- F. Maintain disinfectant in system for 24 hours.
- G. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- H. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- I. Take samples no sooner than 24 hours after flushing, from 5 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

### 3.07 SERVICE CONNECTIONS

- A. Provide new sanitary and storm sewer services connecting to existing building services or utility lines as shown on the drawings.

- B. Before commencing work, field verify invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover as required.
- C. Provide new domestic water service connecting to existing building services or utility lines as shown on plans. Assure connections are in compliance with requirements of the jurisdiction having authority.
- D. Extension of services to the building shall be fabricated from the same materials as the utility service lines or those materials specified herein.
- E. Should points of connection vary from those indicated on the drawings contractor shall properly allow for this in the actual connections field fabricated.

### 3.08 RODDING SEWERS

- A. All sanitary soil and waste lines, both in the building and out, shall be rodded out after completion of the installation.
- B. This Work shall be done, as part of the contract, to make certain that all lines are clear, and any obstruction that may be discovered shall be removed immediately. Rodding shall be accomplished by utilizing a rotary cutter, which shall be full size of pipe being cleaned.

### 3.09 TESTING OF PLUMBING PIPING SYSTEMS

- A. During the progress of the work and upon completion, tests shall be made as specified herein and as required by Authorities Having Jurisdiction, including Inspectors, Owner or Architect. The Architect or duly authorized Construction Inspector shall be notified in writing at least 2 working days prior to each test or other Specification requirement which requires action on the part of the Construction Inspector.
- B. Tests shall be conducted as part of this work and shall include all necessary instruments, equipment, apparatus, and service as required to perform the tests with qualified personnel. Submit proposed test procedures, recording forms, and test equipment for approval prior to the execution of testing.
- C. Tests shall be performed before piping of various systems have been covered or furred-in. For insulated piping systems testing shall be accomplished prior to the application of insulation.
- D. All piping systems shall be tested and proved absolutely tight for a period of not less than 24 hours. Tests shall be witnessed by the Architect or an authorized representative and pronounced satisfactory before pressure is removed or any water drawn off.
- E. Leaks, damage or defects discovered or resulting from test shall be repaired or replaced to a like new condition. Leaking pipe joints, or defective pipe, shall be removed and replaced with acceptable materials. Test shall be repeated after repairs are completed and shall continue until such time as the entire test period expires without the discovery of any leaks.
- F. Wherever conditions permit, each piping system shall thereafter be subjected to its normal operating pressure and temperature for a period of no less than five 5 days. During that period, it shall be kept under the most careful observation. The piping systems must

demonstrate the propriety of their installation by remaining absolutely tight during this period.

G. Domestic Water:

1. Pressure test at one and one half times the normal working pressure or 125 psig, whichever is the greater, for 24 hours.

H. Sanitary Soil, Waste and Vents and Storm Sewer:

1. After the rough-in soil, waste and vent and other parts of the sanitary sewer including branch laterals have been set from the lowest level, at point of connection to existing utility lines, to above the floor line, all outlets shall be temporarily plugged or capped, except as are required for testing as described herein. Ground work shall not permit the backfill of trenches to cover any joints until the completion of testing. Back fill shall be limited to mid sections of full joints of piping only. For pipe in ground the piping shall be readied as described herein and filled with water to a verifiable and visible level to 10' above the lowest portions of the system being tested.
2. On multi-level buildings only one floor level shall be tested at a time. Each floor shall be tested from a level below the structure of the floor, or the outlet of the building in the case of the lowest level, to a level of 12 inches above the floor immediately above the floor being tested, or the top of the highest vent in the case of the highest building level. The pipes for the level being tested shall be filled with water to a verifiable and visible level as described above and be allowed to remain so for 24 hours. If after 24 hours the level of the water has been lowered by leakage, the leaks must be found and stopped, and the water level shall again be raised to the level described, and the test repeated until, after a 24 hour retention period, there shall be no perceptible lowering of the water level in the system being tested.
3. Should the completion of these tests leave any reasonable question or doubt of the integrity of the installation, additional tests including peppermint smoke, or other measures shall be performed to demonstrate the reliability of these systems to the complete satisfaction of the Owner's duly authorized representative. Such tests shall be conducted and completed before any joints in plumbing are concealed or made inaccessible.

3.10 COMPLETE FUNCTIONING OF WORK

- A. All work fairly implied as essential to the complete functioning of the systems shown on the Drawings and Specification shall be completed as part of the work of this Division unless specifically stated otherwise. It is the intention of the Drawings and Specification to establish the type and function of systems but not to set forth each item essential to the functioning of any system. In case of doubt as to the work intended or in the event of amplification or clarification thereof, the Contractor shall call upon the Architect for Supplementary Instructions and Drawings, etc.

**END OF SECTION**

**SECTION 15430**  
**PLUMBING SPECIALTIES**

**PART 1 - GENERAL**

**1.01 WORK INCLUDED**

- A. Roof and floor drains.
- B. Interceptors.
- C. Cleanouts.
- D. Backflow preventors.
- E. Water hammer arrestors.
- F. Thermostatic mixing valves.
- G. Hose bibbs hydrants.

**1.02 RELATED WORK**

- A. Division 7 Roofing: Roof drains.
- B. Section 15140 - Supports and Anchors.
- C. Section 15410 - Plumbing Piping.
- D. Section 15440 - Plumbing Fixtures.

**1.03 REFERENCES**

- A. ANSI/ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent.
- B. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
- C. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
- D. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
- E. ANSI A112.21.1 - Floor Drains.
- F. ANSI A112.21.2 - Roof Drains.
- G. ANSI A112.26.1 - Water Hammer Arresters.
- H. PDI WH-201 Water Hammer Arresters
- I. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.

**1.04 QUALITY ASSURANCE**

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.05 SUBMITTALS

- A. Submit under provisions of Division One.
- B. Submit product data under provisions of Division One.
- C. Include component sizes, rough-in requirements, service sizes, and finishes.
- D. Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.06 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division One.
- B. Record actual locations of equipment, cleanouts, and backflow preventers.

1.07 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division One.
- B. Operation Data: Indicate frequency of treatment required for interceptors.
- C. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division One.
- B. Accept specialties on site in original factory packaging. Inspect for damage.

1.09 EXTRA MATERIALS

- A. Furnish under provisions of Division One.
- B. Provide two loose keys for hose bibbs and spare hose end vacuum breakers.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - ROOF DRAINS

- A. Jay R. Smith
- B. Watts
- C. Zurn
- D. Substitutions: Under provisions of Division One.
- E. Roof Drains
  - 1. Roof Drains: ANSI A112.21.2; Galvanized cast iron body with sump, removable cast aluminum dome strainer, membrane flange and membrane clamp with integral gravel stop, with adjustable underdeck clamp roof sump receiver waterproofing flange

- controlled flow weir leveling frame adjustable extension sleeve (for insulation) perforated or slotted ballast guard extension for inverted roof.
2. Roof Overflow Drains (OD): Galvanized cast iron body and clamp collar and bottom clamp ring; pipe extended to 2 inches above flood elevation.

2.02 ACCEPTABLE MANUFACTURERS - CLEANOUTS

- A. Zurn
- B. Watts
- C. Jay R. Smith
- D. Substitutions: Under provisions of Division One.
- E. Cleanouts
1. Exterior Surfaced Areas: Square cast nickel bronze access frame and non-skid cover;
  2. Exterior Unsurfaced Areas: Line type with lacquered cast iron body and round epoxy coated gasketted cover;
  3. Interior Finished Floor Areas: Galvanized cast iron, two piece body with double drainage flange, weep holes, reversible clamping collar, and adjustable nickel-bronze strainer, round with scoriated cover in service areas and round with depressed cover to accept floor finish in finished floor areas;
  4. Interior Finished Wall Areas: Line type with lacquered cast iron body and round epoxy coated gasketted cover, and 6" round stainless steel access cover secured with machine screw;
  5. Interior Unfinished Accessible Areas: Calked or threaded type., Provide bolted stack cleanouts on vertical rainwater leaders.

2.03 ACCEPTABLE MANUFACTURERS - HOSE BIBBS/HYDRANTS

- A. Woodford
- B. Zurn
- C. Jay R. Smith
- D. Substitutions: Under provisions of Division One.
- E. HOSE BIBBS/HYDRANTS
1. Bronze or brass, replaceable hexagonal disc, hose thread spout, chrome plated where exposed to interior with lockshield and removable key, integral vacuum breaker in conformance with ANSI/ASSE 1011;
  2. Wall Hydrant: ANSI/ASSE 1019; non-freeze, self-draining type with rough chrome plated lockable recessed box hose thread spout, lockshield and removable key, and vacuum breaker;

2.04 RECESSED VALVE BOX

- A. Manufacturers:
1. Oatey.
  2. Other acceptable manufacturers offering equivalent products.
  3. Sioux Chief



4. Guy Gray.
5. Washing Machine: Plastic preformed rough-in box with brass quarter turn ball valves and water hammer arrestors on both hot and cold connections, socket for waste, slip in finishing cover;
6. Refrigerator: Plastic preformed rough-in box with quarter turn brass ball valve, slip in finishing cover;

## 2.05 ACCEPTABLE MANUFACTURERS - BACKFLOW PREVENTORS

- A. Watts
- B. Wilkins
- C. Febco
- D. Substitutions: Under provisions of Division One.
- E. BACKFLOW PREVENTERS
  1. Reduced Pressure Backflow Preventers: ANSI/ASSE 1013; bronze body with bronze and plastic internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve which opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks;
  2. Double Check Valve Assemblies: ANSI/ASSE 1012; Bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent;

## 2.06 ACCEPTABLE MANUFACTURERS - WATER HAMMER ARRESTORS

- A. Sioux Chief
- B. Wilkins
- C. Zurn
- D. Substitutions: Under provisions of Division One.
- E. WATER HAMMER ARRESTORS
  1. ANSI A112.26.1; sized in accordance with PDI WH-201, precharged suitable for operation in temperature range -100 to 300 degrees F (-73 to 149 degrees C) and maximum 250 psig (1700 kPa) working pressure;

## 2.07 ACCEPTABLE MANUFACTURERS - OIL INTERCEPTORS

- A. Park USA
- B. Jay R. Smith
- C. Mifab
- D. Substitutions: Under provisions of Division One.
- E. Oil Interceptors

1. Construction: Precast concrete for flush with floor (deep rough-in) installation, with anchor flange, multi-weir bucket assembly, integral deep seal trap, adjustable draw-off assembly, and galvanized H20 traffic rated lid.

2.08 ACCEPTABLE MANUFACTURERS - THERMOSTATIC MIXING VALVES

- A. Powers
- B. Bradley
- C. Leonard
- D. Substitutions: Under provisions of Division One.
- E. Thermostatic Mixing Valves
  1. Provide thermostatic mixing valve, with check valve, volume control shut-off valve on outlet, stem type thermometer on outlet, strainer stop check on inlet, mounted in lockable cabinet of 16 gage (1.5 mm) prime coated steel.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Coordinate cutting, forming of roof and/or floor construction to receive drains to required invert elevations.

3.02 INSTALLATION AND APPLICATION

- A. Install specialties in accordance with manufacturer's instructions to permit intended performance.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C. Encase exterior cleanouts in concrete flush with grade.
- D. Pipe relief from back flow preventer to nearest drain.

**END OF SECTION**

**SECTION 15440**  
**PLUMBING FIXTURES**

**PART 1 - GENERAL**

**1.01 GENERAL REQUIREMENTS**

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 15050, are included as a part of this Section as though written in full in this document.

**1.02 SCOPE**

Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

- A. **WORK INCLUDED:** Include the following Work in addition to items normally part of this Section:
  - 1. Plumbing fixtures.
  - 2. Drains and cleanouts.
- B. **WORK SPECIFIED ELSEWHERE:**
  - 1. Piping systems.
  - 2. Pipe valves, and fittings.
  - 3. Plumbing systems testing.

**1.03 WARRANTY**

- A. Warrant the Work specified herein for one year against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to, the following:
  - 1. Noisy operation.
  - 2. Noticeable deterioration of finish.
  - 3. Leakage of water.

**1.04 SUBMITTALS**

- A. **SHOP DRAWINGS:** Indicate size, material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.
- B. **PRODUCT DATA:** Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, and accessories.
- C. **OPERATION AND MAINTENANCE INSTRUCTIONS:** Provide pre-printed operating and maintenance instructions for each item specified. Instruct and demonstrate the proper operation and maintenance to the Owner's designated representative.

## 1.05 DELIVERY AND STORAGE

- A. DELIVERY: Deliver clearly labeled, undamaged materials in the manufacturers' unopened containers.
- B. TIMING AND COORDINATION: Deliver materials to allow for minimum storage time at the project site. Coordinate delivery with the scheduled time of installation.
- C. STORAGE: Store materials in a clean, dry location, protected from weather and abuse.

## 1.06 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.
- B. Confirm and field coordinate that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

#### A. PLUMBING FIXTURES:

- 1. GENERAL: Provide plumbing fixtures as specified on drawings. The approved equal products manufacturers are as follows:
  - a. Water closet, urinals, lavatories, bath tubs and showers: American Standard, Kohler, Eljer.
  - b. Stainless steel sinks: Elkay, Just and Moen.
  - c. Mop sinks: Stern-Williams, Fiat
  - d. Faucets: American Standard, Kohler, Eljer,
  - e. Faucets: Chicago, T&S Brass, Zurn
  - f. Faucets: Moen, Delta Commercial, Speakman
  - g. Shower valves: Leonard, Powers, Symmons, Chicago
  - h. Shower Systems: Bradley, Acorn, Willoughby
  - i. Flush Valves: Sloan "Royal", Zurn "AquaVantage"
  - j. Drinking fountains: Halsey Taylor, Elkay, Haws, Acorn Aqua.
  - k. Floor drains and roof drains: Zurn, J.R. Smith, Josam and Watts.
  - l. Emergency Fixtures: Bradley, Chicago, Haws, Speakman and Encon
- 2. CHAIR CARRIERS: ANSI/ASME A112.6.1.; Adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers. As manufactured by Zurn, J. R. Smith, Josam or Wade.
- 3. DRINKING FOUNTAIN & URINAL WALL SUPPORTS: ANSI/ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs. As manufactured by Zurn, J. R. Smith, Josam or Wade.
- 4. TRAPS, STOPS AND RISERS: Heavy pattern as manufactured by McGuire, Chicago or Zurn.

#### B. CLEANOUTS:

- 1. GENERAL: Provide cleanouts as shown on Drawings and as required by the city building code.

2. ACCEPTABLE MANUFACTURERS: Zurn J. R. Smith, Josam and Watts.
3. TYPES:
  - a. FINISHED FLOOR CLEANOUTS: Provide cast iron, adjustable floor level assembly with round nickel bronze top and gasket cover.
  - b. RESILIENT OR TILE FINISHED FLOOR CLEANOUTS: Provide cast iron, adjustable assembly with round nickel-bronze top with gasketed water tight cover and depressed top to receive flooring finish material.
  - c. DRY WALL CLEANOUTS: Provide cast iron tee and counter sink bronze plug with square nickel bronze frame and stainless steel cover.
  - d. Provide membrane clamp rings for slab on grade cleanouts.
  - e. All cleanouts shall have tapered bronze plugs.
  - f. All cleanouts outside of building on grade shall be set in a 18" x 18" x 4" thick concrete pad.

### PART 3 - EXECUTION

#### 3.01 PREPARATION

- A. EXAMINATION OF CONDITIONS: Examine conditions affecting this Work. Report unsatisfactory conditions to the proper authority and do not proceed until those conditions have been corrected. Commencing Work implies acceptance of existing conditions as satisfactory to the outcome of this Work.

#### 3.02 INSTALLATION

- A. Install fixtures in locations and heights as shown on Drawings or as directed by the Architect.
- B. Install materials plumb, level, securely, and in accordance with manufacturer's recommendations.
- C. All rough-in pipe openings, for final connections with all supply waste soil and vent systems shall be closed with caps or plugs during early stages of construction and installation. Tape shall not be considered sufficient protection.
- D. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.
- E. Provide gate valves in piping serving batteries of fixtures. Label stops "Hot" and "Cold." Valves to be located above accessible ceiling. If ceiling are not accessible, provide access panels of adequate size to make valves fully accessible.
- F. Plumbing fixtures shall be supported by a concealed chair carrier where required to properly support the fixture specified. All carriers to be securely mounted, bolted and checked prior to concealment.
- G. Caulk around fixtures with best grade white silicone caulking. Do not use grout.
- H. All handles on supply and drainage fittings or other brass items shall be properly lined up and adjusted. Fittings shall not be left in any haphazard manner.
- I. All fixtures shall have individual chrome plated loose key cutoff stops on supply lines. Where same are not specified as a part of the fixture trim, they shall be installed as close to fixtures as possible in the hot and cold water supply.
- J. Install each fixture with trap, easily removable for servicing and cleaning.

K. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

L. Hot and cold water riser air chambers: Provide air chambers for hot and/or cold water riser located at the rough-in tee at all fixtures.

The air chamber shall be of the same materials and the next larger diameter than the required rough-in supply pipe and a minimum of 24" tall.

The contractor may install water hammer arrestors in lieu of air chambers. Water hammer arrestors shall be PDI Certified and sized and placed as recommended by manufacture. Provide an accessible isolation valve and proper access to arrestor for replacement.

### 3.03 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

### 3.04 ADJUSTING

A. Adjust work under provisions of Division One.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

### 3.05 CLEANING

A. Clean work under provisions of Division One.

B. At completion clean plumbing fixtures and equipment.

### 3.06 PROTECTION OF FINISHED WORK

A. Protect finished Work under provisions of Division One.

B. Do not permit use of fixtures.

### 3.07 ADA ACCESSIBLE FIXTURES

A. Install fixtures to heights, indicated on architectural drawings.

B. Handicapped fixtures shall be installed to required heights, shall be of types suitable for, and supplied with controls properly installed, to comply with requirements as directed by ADA Accessibility of Federal Registry, Part III, Department of Justice 28 CFR 36 and comply with all state and local ADA Code requirements.

C. Exposed accessible sink or lavatory p-trap and angle valve assemblies shall be insulated with the fully molded, Truebro, Handi Lav-guard insulation kit. Provide the proper model for fixtures specified. All kits shall be White or as selected by Architect.

D. Wall mounted drinking fountains and coolers which protrude into passages or corridor space, whether single or paired with adjacent accessible fixture, shall be supplied with skirt or apron to lower the underside clearance of non-accessible fixture equal to that required for

accessible fixture.

**END OF SECTION**

**SECTION 15450**  
**PLUMBING EQUIPMENT**

**PART 1 - GENERAL**

**1.01 SECTION INCLUDES**

- A. Water Heaters.

**1.02 RELATED SECTIONS**

- A. Section 15140 - Supports and Anchors.
- B. Section 15240 - Vibration Isolation.
- C. Section 15410 - Plumbing Piping.
- D. Section 15430 - Plumbing Specialties.
- E. Section 16180 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

**1.03 REFERENCES**

- A. ANSI/ASHRAE 90A - Energy Conservation in New Building Design.
- B. ASME Section VIII D - Pressure Vessels; Boiler and Pressure Vessel Codes.
- C. ANSI/NFPA 54 - National Fuel Gas Code.
- D. ANSI/NFPA 70 - National Electrical Code.
- E. ANSI/UL 1453 - Electric Booster and Commercial Storage Tank Water Heaters.

**1.04 SUBMITTALS**

- A. Submit under provisions of Division One.
- B. Shop Drawings:
  - 1. Include heat exchanger dimensions, size of tapings, and performance data.
  - 2. Include dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tapings, and drains.
- C. Product Data:
  - 1. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.
  - 2. Indicate pump type, capacity, power requirements, and affected adjacent construction.
  - 3. Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
  - 4. Provide electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions.



#### 1.05 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division One.
- B. Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

#### 1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with authorities having jurisdiction.
- B. Provide pumps with manufacturer's name, model number, and rating/capacity identified.
- C. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:
  - 1. American Gas Association (AGA).
  - 2. National Sanitation Foundation (NSF).
  - 3. American Society of Mechanical Engineers (ASME).
  - 4. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
  - 5. National Electrical Manufacturers' Association (NEMA).
  - 6. Underwriters Laboratories (UL).
- D. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

#### 1.07 REGULATORY REQUIREMENTS

- A. Conform to AGA NSF ANSI/NFPA 54 ANSI/NFPA 70 ANSI/UL 1453 requirements for water heaters.
- B. Conform to ASME Section VIII for manufacture of pressure vessels for heat exchangers.

#### 1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section Division One.
- B. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

#### 1.09 WARRANTY

- A. Provide five year warranty under provisions of Division One.
- B. Warranty: Include coverage of domestic water heaters, water storage tanks, and packaged water heating systems.

#### 1.10 EXTRA MATERIALS

- A. Furnish under provisions of Division One.
- B. Provide two sets of electric heater elements.

### PART 2 - PRODUCTS

## 2.01 RESIDENTIAL GAS FIRED WATER HEATER

- A. Manufacturers:
  - 1. A.O. Smith.
  - 2. Other acceptable manufacturers offering equivalent products.
    - a. Rheem.
    - b. State.
    - c. Lochinvar.
- B. Type: Automatic, natural gas-fired, vertical storage.
- C. Tank: Glass lined welded steel with single flue passage, flue baffle and draft hood; thermally insulated with glass fiber and encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs.
- D. Controls: Automatic water thermostat and built-in gas pressure regulator; temperature range adjustable from 120 to 170 degrees F (49 to 77 degrees C), cast iron or sheet metal burner, safety pilot and thermocouple.
- E. Accessories: Brass water connections and dip tube, drain valve, high density magnesium anode, and ASME temperature and pressure relief valve.

## 2.02 COMMERCIAL ELECTRIC WATER HEATERS

- A. Manufacturers:
  - 1. State.
  - 2. Other acceptable manufacturers offering equivalent products.
    - a. A.O. Smith.
    - b. Rheem.
- B. Type: Factory-assembled and wired, electric, [vertical] [horizontal] storage.
- C. Tank: Glass lined welded steel; 4 inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber encased in corrosion-resistant steel jacket; baked-on enamel finish.
- D. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F (16 to 82 degrees C), flanged or screw-in nichrome elements, high temperature limit thermostat.
- E. Accessories: Brass water connections and dip tube, drain valve, high-density magnesium anode, and ASME rated temperature and pressure relief valve.

## PART 3 - EXECUTION

### 3.01 WATER HEATER INSTALLATION

- A. Install water heaters in accordance with manufacturer's instructions and to AGA NSF ANSI/NFPA 54 UL requirements.
- B. Coordinate with plumbing piping and related work to achieve operating system.
- C. Provide secondary drain pan and route secondary drain pipe to a point indicated on the

drawings.

- D. Route TPR drain line to the exterior of the building and terminate 6 inches above grade.
- E. Provide 18 inch high galvanized stand manufactured for supporting water heaters.

**END OF SECTION**

## SECTION 15481

### COMPRESSED AIR SYSTEMS

#### PART 1 - GENERAL

##### 1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Division-15 Basic Mechanical Materials and Methods sections apply to work of this section.

##### 1.02 DESCRIPTION OF WORK

- A. Extent of compressed air systems work, is indicated on drawings and schedules, and by requirements of this section.
- B. Refer to Division-16 sections for the following work; not work of this section.
  - 1. Power supply wiring from power source to power connection on compressed air equipment. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
  - 2. Interlock wiring between electrically-operated compressed air equipment units; and between equipment and field-installed control devices.
    - a. Interlock wiring specified as factory-installed is work of this section.
- C. Provide the following electrical work as work of this section, complying with requirements of Division-16 sections:
  - 1. Control wiring between field-installed controls, indicating devices, and unit control panels.

##### 1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of compressed air systems equipment and products, of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer Qualifications: Firm with at least 3 years of successful installation experience on projects with compressed air systems work similar to that required for project.
- C. Codes and Standards:
  - 1. ASME Compliance: Provide compressed air pressure vessels and relief valves in accordance with ASME "Boiler and Pressure Vessel Code"; provide ASME Code Symbol Stamp.
  - 2. ASME Compliance: Fabricate and install compressed air systems in accordance with ASME B31.9 "Building Services Piping".
  - 3. CGA Compliance: Fabricate and install compressed air systems in accordance with CGA Standards (Compressed Gas Association).
  - 4. UL Compliance: Provide electrical components which are UL listed and have UL label affixed.

##### 1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for compressed air systems materials and products.
- B. Record Drawings: At project closeout, submit record drawings of installed piping, and compressed air systems products; in accordance with requirements of Division 1.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Maintenance Data: Submit maintenance data and parts lists for compressed air systems materials and products. Include this data, product data, shop drawings, record drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver compressed air equipment, including compressed air dryers and receiver tanks with factory-installed skid; with accessories as scheduled on the plans.

### PART 2 - PRODUCTS

#### 2.01 ACCEPTABLE MANUFACTURERS

- A. Quincy
- B. Ingersoll – Rand
- C. Champion

#### 2.02 BASIC IDENTIFICATION

- A. General: Provide identification complying with Division-15 Basic Mechanical Materials and Methods section "Mechanical Identification", in accordance with the following listing:
  - 1. Piping Above Ground: Plastic pipe markers.
  - 2. Valves: Plastic valve tags.

#### 2.03 BASIC PIPES AND PIPE FITTINGS

- A. General: Provide pipes and pipe fittings complying with Division-15 Basic Mechanical Materials and Methods.
- B. All Sizes: Copper tube, hard-temper for exposed locations, soft-temper for underground and concealed locations; Type "L"; wrought-copper, solder-joint fittings

#### 2.04 BASIC SUPPORTS AND ANCHORS

- A. General: Provide supports and anchors, complying with Division-15 Basic Mechanical Materials and Methods section "Supports and Anchors", in accordance with the following listing:
  - 1. Extension split pipe clamp, copper plated, hinged or 2-bolt for pipe support from any substrate.

## 2.05 VALVES

- A. Shutoff Valves: Provide compressed air shutoff valves, bronze-body, double seal, full port, union ball type, with seat seals and stem seals. Design so quarter turn of lever-type valve handle is maximum travel between open and closed positions. Design for working pressure of 300 psi minimum. Provide valves with color-coded gas identification labels.

## 2.06 BASIC VIBRATION CONTROL

- A. General: Provide vibration control products complying with Division-15 Basic Mechanical Materials and Methods section "Vibration Control", in accordance with the following listing:

## 2.07 COMPRESSED AIR EQUIPMENT AND ACCESSORIES

- A. General: Provide air compressor system, size as specified on drawings.
- B. The air compressor system shall be of a single point connection, base mounted design consisting of two compressor, two motors, and regulator, integral pre-wired control panel and corrosion resistant air receiver. The complete package shall be pre-wired, pre-piped, and assembled on one common base with single point connection for electrical.
- C. Compressor Module: The compressor shall be a continuous duty rated. The design shall be single stage, air-cooled, rated for 120 psig discharge pressure. The compressor shall be v-belt driven with totally enclosed belt guard. The drive motor shall be a NEMA rated, open drip proof, 3600 RPM, with 1.15 service factor suitable for 208 or 230/460V electrical service.
- D. Isolation System: The compressor and motor shall be fully isolated from the air receiver by means of a four point spring isolation system.
- E. Air Receiver: The vertical air receiver shall be corrosion resistant, ASME coded, National Board Certified, rated for a minimum 150 psig design pressure, and include a liquid level gauge glass, safety relief valve, manual drain valve, and a timed automatic solenoid drain valve.
- F. Motor and housing shall be outdoor rated in a NEMA 3R enclosure.

## PART 1 - EXECUTION

### 3.01 INSPECTION

- A. Examine areas and conditions under which compressed air systems and equipment are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

### 3.02 INSTALLATION OF BASIC IDENTIFICATION

- A. General: Install mechanical identification in accordance with Division-15 Basic Mechanical Materials and Methods section "Mechanical Identification".

### 3.03 INSTALLATION OF COMPRESSED AIR PIPING

- A. General: Install piping in accordance with Division- 15 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings".

### 3.04 INSTALLATION OF SUPPORTS AND ANCHORS

- A. Install supports and anchors, in accordance with Division-15 Basic Mechanical Materials and Methods section "Supports and Anchors". Locate spacing for supports and anchors in accordance with piping manufacturer's recommendations.
- B. Support Spacing: Install piping supports at the following maximum intervals:
  - 1. 1/2" Pipe Size: 6' o.c.
  - 2. 3/4" to 1" Pipe Size: 8' o.c.
  - 3. 1-1/4" or Larger Pipe Size: 10' o.c.
  - 4. Vertical Piping: Every floor level.

### 3.05 INSTALLATION OF VALVES

- A. Shutoff Valves: Provide shutoff valves where indicated, on plans.

### 3.06 INSTALLATION OF EQUIPMENT AND ACCESSORIES

- A. Install equipment and accessories where indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that compressed air equipment and accessories comply with requirements and serve intended purposes.
- B. Coordinate with other work including plumbing, as necessary to interface installation of compressed air piping and equipment with other work.
- C. Support: Install equipment on 4" high reinforced concrete pads, 4" larger on each side than equipment base. Cast anchor bolt inserts into pad.
- D. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
  - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-16 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

### 3.07 EQUIPMENT CONNECTIONS

- A. General: Connect compressed air systems to mechanical equipment as indicated, and comply with equipment manufacturer's instructions where not otherwise indicated.

### 3.08 FIELD QUALITY CONTROL

- A. Test compressed air alarms for proper operation at high pressure, low pressure.

## END OF SECTION

**SECTION 15530**  
**REFRIGERANT PIPING**

**PART 1 - GENERAL**

**1.01 GENERAL REQUIREMENTS**

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 15050, are included as a part of this Section as though written in full in this document.

**1.02 SCOPE**

Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

**PART 2 - PRODUCTS**

**2.01 GENERAL**

Provide for the systems as shown. Submit shop drawings of piping systems showing all traps, pipe sizes, and accessories; drawing to be marked "Approved", and signed by a representative of the Application Engineering Department of the condensing unit manufacturer. Pipe sizes shall be as recommended by unit manufacturer. Refer to piping schematic on drawings.

**2.02 MATERIAL**

- A. PIPE: Copper ACR tubing.
- B. FITTINGS: Wrought copper streamlined sweat fitting.
- C. SOLDER: Sil-Fos, except on valves use solder recommended by valve manufacturer.

**2.03 ACCESSORIES**

All accessories shall be UL listed and rated in accordance with ARI Standard 710.

- A. On systems 7-1/2 tons and larger, each separate refrigerant circuit shall have a separate filter dryer. Each filter dryer shall have a replaceable core and a three valve bypass. The filter drier shall be full line size and installed in the refrigerant liquid line. The filter shall have a minimum 4-3/4 inches diameter shell with removable flange and gasket. Flange shall be tapped for 1/4 inch FPT access valve. Size filter-drier for maximum 2.0 psi pressure drop at evaporator operating temperature. Similar to Mueller Brass Company model Drymaster micro-guard refillable filter series SD-485 through SD19217 or Sporlan catch-all.
- B. On systems less than 7-1/2 tons, the filter dryer shall be the sealed type sizes as above. One drier per refrigerant circuit.
- C. Liquid-Moisture Indicator shall be installed in liquid refrigerant line full line size similar to Mueller Brass Company model "Vuemaster" with soldered ends.
- D. Thermostatic expansion valve shall have adjustable super heat and be as manufactured by Sporlan.



#### 2.04 EVACUATION

Evacuate moisture completely by applying a commercial vacuum pump for a minimum of 24 hours. Moisture indicator shall indicate a completely moisture-free condition at time of final inspection. The vacuum pump shall run until the system indicates a maximum of 35 degrees FDB. The system shall be flushed with the operating refrigerant and the vacuum pump connected and rerun to repeat the evacuation. Evaluation shall be performed under supervision of the Engineer.

#### 2.05 FREON AND OIL

- A. Contractor shall leave the refrigeration system with a full charge of freon and oil and shall be responsible for the maintenance of a full charge of freon and oil in the systems for a period of one year from date of acceptance.
- B. Should any leaks in the refrigeration system occur during the guarantee period, the Contractor shall eliminate such leaks and recharge system to a full charge of freon and oil at no cost to the Owner.

#### PART 3 - EXECUTION

- 3.01 All equipment and piping shall be installed in accordance with the manufacturers recommendations and printed installation instructions.
- 3.02 All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturer's requirements.

**END OF SECTION**

## **SECTION 15671**

### **AIR COOLED CONDENSING UNITS**

#### **PART 1 - GENERAL**

##### **1.01 GENERAL REQUIREMENTS**

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 15050, are included as a part of this Section as though written in full in this document.

##### **1.02 SCOPE**

Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

#### **PART 2 - PRODUCTS**

##### **2.01 AIR-COOLED CONDENSING UNITS**

- A. Air-cooled condensing unit shall be designed for use with split system having a remote direct-expansion (DX) cooling coil mounted in evaporator fan unit. Capacity shall be as called for on the drawings when matched to the appropriate evaporator coil.
- B. Condensing unit shall consist of high-efficiency hermetic compressor, air-cooled condenser with quiet fan, factory wired controls, R-410A refrigerant and refrigeration circuit and valves.
- C. Cabinet shall be heavy-gauge galvanized steel with bonding primer and baked-enamel finish coat. The entire cabinet shall be protected from rust.
- D. Compressor shall be protected from excessive current and temperatures and shall be provided with a thermostatically controlled crankcase heater to operate only when needed for protection of the compressor. Compressor shall be spring-mounted on rubber isolators. Compressor shall be located in compartment isolated from condenser fan and coil. Provide a high-capacity dryer in the system to remove moisture and dirt.
- E. Condenser fan shall be directly connected to a weather-protected, quiet, high-efficiency motor. Fan guard shall be provided and shall be protected from rust by PVC finish. Condenser coil shall be aluminum fin with copper tube.
- F. Connections for refrigerant suction and liquid lines shall be extended outside the cabinet and provided with service valves with gauge connections.
- G. Power connections shall be made to the connectors located inside the electrical connection box.
- H. Standard operating and safety controls shall include high-pressure switch, low pressure switch, compressor overload service, and solid-state timed-off control.
- I. All components (parts and labor) of the sealed refrigeration circuit shall be warranted by the manufacturer for five years.

## 2.02 AUXILIARY EQUIPMENT

- A. Auxiliary equipment shall consist of refrigerant lines prepared for the unit involved. These lines shall be cleaned, dried, and pressurized at the factory.
- B. Low ambient kit to allow operation at outside temperature below 35 deg. F (2 deg. C) shall be provided.
- C. Expansion valve shall be provided with the evaporator coil.
- D. Provide thermostat to match the requirements of the job. Thermostat shall provide subbase with Heat-Cool-Off and Fan On-Auto switch. See section on controls for other related requirements.
- E. Provide polyethylene structural base designed for that service and intended to support the unit and eliminate vibration transmission.
- F. Provide hard-start kit with unit.
- G. Provide guards for condenser coils.

## 2.03 ACCEPTABLE MANUFACTURERS

- A. Condensing unit shall be the make and model number shown on the drawings or acceptable equivalents by Lennox, Carrier, Daikin, or Trane.

## PART 3 - EXECUTION

3.01 All HVAC equipment shall be installed as per manufacturers printed installation instructions.

3.02 All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturers requirements.

## 3.03 INSTALLATION

- A. Install the condensing unit on proper foundation as shown on the drawings, and in location that will not restrict the air entry or discharge from the unit.
- B. Install refrigerant lines as recommended by the manufacturer, taking care not to lose the refrigerant charge contained in the lines, or allow air to enter the lines or equipment. Locate the lines in such a way as to not obstruct access to the condensing unit or other equipment. Lines located under ground or under concrete shall be installed in a PVC pipe conduit for protection.
- C. Provide electrical connections as required by the applicable codes. Provide control wiring required. All power wiring and control wiring shall be in conduit and located so as not to obstruct access to the unit or other equipment.

## 3.04 TESTING

- A. Operate the condensing unit and the system to assure that unit is operating properly and without excessive noise and vibration.
- B. Read and record the power draw and the refrigeration suction and liquid pressures as required by Balancing and Test, Section 15990.

## END OF SECTION

## **SECTION 15854**

### **DX" FAN COIL UNIT**

#### **PART 1 - GENERAL**

##### **1.01 GENERAL REQUIREMENTS**

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 15050, are included as a part of this Section as though written in full in this document.

##### **1.02 SCOPE**

Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

#### **PART 2 - PRODUCTS**

##### **2.01 FAN COIL UNITS**

Fan coil units shall be factory built, manufactured as scheduled on drawings. Carrier, Trane or Daikin shall be considered as equal, if they comply with the specification and schedule. Special Note: Contractor shall field verify exact clearances required for air handling units. Units shall be field located as required and shop drawings shall indicate final location for approval by Architect/Engineer.

- A. Furnish and install fan coil units of the type, capacities, ratings and drive motor horsepower shown on the drawings.
- B. Units shall be factory fabricated, draw-thru type, and shall have fan section, cooling coil section, condensate drain pan, adjustable blower drive with motor on resilient mounted base, vee-belts with guard, filter section, and mixing box (if scheduled) assembled as integrated air handling units.
- C. REQUIREMENTS:
  - 1. Mill-galvanized steel, rigidly framed, braced, and reinforced; access panels each side of unit; minimum panel ga. - 18; minimum weight formed framing member 14 ga.
  - 2. Fan section, cooling coil section, and outlet frame throats shall be internally insulated at the factory with 1" thick, 3/4 PCF density, Neoprene coated fiberglass cemented in place with water-proof adhesive, having fire-retardant characteristics in accordance with NFPA 90A.
  - 3. Drain pan shall be not lighter than 14 ga.; extend completely under the coil section and be all-galvanized, foam insulated pan with drain connections.
  - 4. When the fan coil unit is installed above an accessible ceiling, the unit shall incorporate a secondary drain pan. The secondary pan shall be fabricated from galvanized sheet metal, 16 gauge minimum with cross breaking sloped towards a drain. The sides shall be a minimum 2" tall and the corners shall be soldered watertight. The top edge shall have a 1/4" hem to provide additional rigidity and the secondary pan shall be supported at a minimum of six points. The pan shall extend on all sides a minimum of 3" beyond the sides of the unit casing. Route the secondary drain piping to a conspicuous location or install a float switch at the low point in the secondary pan. The secondary pan should be sloped a minimum

- of 1/8" per foot and supported so that the unit is not in contact with the bottom of the secondary pan.
5. The fan section, including wheels, shafts, bearings, drive, etc., shall be statically and dynamically balanced as an assembly, and the shaft shall not pass through the first critical speed, while accelerating from rest to operating speed. Submittal data shall state the first critical shaft speed. Shaft bearings shall be of vacuum de-gassed steel, and shall be selected for 200,000 hours average life.
  6. Coil shall be as hereinafter specified.

## 2.02 COILS

- A. Cooling coils shall be cartridge type and, when mounted in air handling units, shall be removable from either end. Coils shall be constructed of copper tubes with aluminum fins and shall be designed for even distribution of air across the face of the coils; air shall not pass around coil frames: Coils shall have same end connection for DX or chilled water piping.
- B. DX refrigerant coils shall be counter-flow refrigerant to air, shall have inlet and outlet connections permanently marked shall have thermostatic expansion valves with adjustable super heat.
- C. Maximum face velocity across cooling coils shall be 500 FPM, unless noted otherwise on schedule.

## PART 3 - EXECUTION

- 3.01 All HVAC equipment shall be installed as per manufacturers printed installation instructions.
- 3.02 All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturers requirements.

## END OF SECTION

**SECTION 15860**  
**POWER VENTILATORS**

**PART 1 - GENERAL**

**1.01 WORK INCLUDED**

- A. Ceiling and inline ventilators.

**1.02 RELATED SECTIONS**

- A. Section 15050 – Basic Materials and Methods
- B. Section 15170 – Motors and Motor Controllers
- C. Section 15240 – Sound and Vibration Control
- D. Section 15951 – Controls
- E. Section 15990 – Testing, Adjusting and Balancing

**1.03 QUALITY ASSURANCE**

- A. UL Compliance: Fans shall be designed, manufactured, and tested in accordance with UL 705 "Power Ventilators."
- B. UL Compliance: Fans and components shall be UL listed and labeled.
- C. Nationally Recognized Testing Laboratory Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.
- D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- E. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- F. Sound Power Level Ratings: Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating." Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
- G. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.

**1.04 SUBMITTALS**

- 1. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:
- 2. Product data for selected models, including specialties, accessories, and the following:

- a. Certified fan performance curves with system operating conditions indicated.
  - b. Certified fan sound power ratings.
  - c. Motor ratings and electrical characteristics plus motor and fan accessories.
  - d. Materials gages and finishes, include color charts.
  - e. Dampers, including housings, linkages, and operators.
  - f. Full color paint samples.
- 3. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
  - 4. Coordination drawings, in accordance with Division 15 Section "Basic Materials and Methods", for roof penetration requirements and for reflected ceiling plans drawn accurately to scale and coordinating penetrations and units mounted above ceiling. Show the following:
    - a. Roof framing and support members relative to duct penetrations.
    - b. Ceiling suspension members.
    - c. Method of attaching hangers to building structure.
    - d. Size and location of initial access modules for acoustical tile.
    - e. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinkler heads, access panels, and special moldings.
  - 6. iring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field- installed wiring.
  - 7. Product certificates, signed by manufacturer, certifying that their products comply with specified requirements.
  - 8. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 15 Section "Basic Materials and Methods".

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Fans shall be stored and handled in accordance with the unit manufacturer's instructions.
- B. B. Lift and support units with the manufacturer's designated lifting or supporting points.
- C. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.
- D. Deliver fan units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

#### 1.06 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

### PART 2 - PRODUCTS

#### 2.01 ACCEPTABLE MANUFACTURERS

- A. ACME, Inc.
- B. Loren Cook Company

- C. Greenheck Fan Corporation
- D. Substitutions under provisions of Division One.

## 2.02 GENERAL DESCRIPTION

- A. Provide fans that are factory fabricated and assembled, factory tested, and factory finished with indicated capacities and characteristics.
- B. Fans and Shafts shall be statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.
- C. Provide factory baked-enamel finish coat after assembly. Color shall be verified during the submittal process.

## 2.03 CEILING AND INLINE VENTILATORS

- A. Ceiling and inline ventilators shall be direct drive or belt drive as indicated, centrifugal blower type. Fan wheel shall be constructed of galvanized steel and shall be dynamically balanced. The housing shall be constructed of minimum 20 gauge corrosion resistant galvanized steel and acoustically insulated for quiet operation. Blower and motor assembly shall be easily removable from the housing without disturbing the ductwork. The motor shall be permanently lubricated with built-in thermal overload protection and shall be factory tested prior to shipment. The ceiling ventilators shall be furnished standard with a powder-painted white steel grille.
- B. Ventilators shall be certified and licensed to bear the AMCA Seal for Air and Sound Performance. Ventilator performance shall be based on tests and procedures performed in accordance with AMCA publication 211 and comply with the requirements of the AMCA Certified Ratings Program. Fan sound power level ratings shall be based on tests and procedures performed in accordance with AMCA publication 311 and comply with the requirements of the AMCA Certified Ratings Program. Ventilators shall be UL listed and CSA certified.
- C. Accessories: The following accessories are required.
  - 1. Dampers:
    - a. Aluminum backdraft damper.
    - b. Motor-operated volume control damper.
  - 2. Disconnect Switch: Nonfusible type with thermal overload protection.
  - 3. Speed Controls: Fan mounted, solid state speed controller.

## PART 3 – EXECUTION

- 3.01 Install in accordance with manufacturer's instructions.
- 3.02 All items required for a complete and proper installation are not necessarily indicated on the plans or in the specifications. Provide all items required as per manufacturer's requirements.

## END OF SECTION



## **SECTION 15881**

### **AIR DISTRIBUTION DEVICES**

#### **PART 1 - GENERAL**

##### **1.01 WORK INCLUDED**

- A. Ceiling air diffusers.
- B. Wall registers and grilles.
- C. Louvers.
- D. Other air devices indicated on drawings and schedules.

##### **1.02 RELATED SECTIONS**

- A. Section 15050 – Basic Materials and Methods
- B. Section 15890 – Metal Ductwork
- C. Section 15910 – Ductwork Accessories
- D. Section 15990 – Testing, Adjusting and Balancing

##### **1.03 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air distribution devices of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
  - 1. ARI Compliance: Test and rate air distribution devices in accordance with ARI 650 "Standard for Air Outlets and Inlets".
  - 2. ASHRAE Compliance: Test and rate air distribution devices in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
  - 3. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".
  - 4. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.
  - 5. NFPA Compliance: Install air distribution devices in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

##### **1.04 SUBMITTALS**

- A. Product Data: Submit manufacturer's technical product data for air distribution devices including the following:
  - 1. Schedule of air distribution devices indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
  - 2. Data sheet for each type of air distribution devices, and accessory furnished; indicating construction, finish, and mounting details.

3. Performance data for each type of air distribution devices furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings. Indicate selections on data.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air distribution devices, indicating materials and methods of assembly of components.
- C. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

#### 1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver air distribution devices wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
- B. Store air distribution devices in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

#### 1.06 WARRANTY

- A. Warrant the installation of the Work specified herein for one year against becoming unserviceable or causing an objectionable appearance resulting from defective or nonconforming workmanship.

### PART 2 – PRODUCTS

#### 2.01 ACCEPTABLE MANUFACTURERS

- A. Titus Company
- B. Metalaire Industries, Inc.
- C. Nailor Industries
- D. Krueger
- E. Substitutions under provisions of Division One.

#### 2.02 GENERAL DESCRIPTION

- A. Unless otherwise indicated, provide manufacturer's standard air devices when shown of size, shape, capacity, type and accessories indicated on drawings and schedules, constructed of materials and components as indicated and as required for complete installation and proper air distribution.
- B. Provide air devices that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.
- C. Unless noted otherwise on drawings, the finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100 hour ASTM D117 Corrosive Environments Salt Spray Test without creepage, blistering, or deterioration of film. The paint must pass a 250 hour ASTM-870

Water Immersion Test. The paint must also pass the ASTM D-2794 Reverse Impact Cracking Test with a 50 inch pound force applied.

- D. Provide air device with border styles that are compatible with adjacent ceiling or wall system, and that are specially manufactured to fit into the wall construction or ceiling module with accurate fit and adequate support. Refer to architectural construction drawings and specifications for types of wall construction and ceiling systems.
- E. Provide integral volume damper with roll formed steel blades where indicated on drawings or schedules. Dampers shall be opposed blade design with a screw driver slot or a concealed lever operator for adjustment through the face of the air device.
- F. Air devices designated for fire rated systems shall be pre-assembled with UL classified radiation damper and thermal blanket. Fire rated air devices shall be shipped completely assembled; one assembly per carton. Each assembly shall be enclosed in plastic shrink wrap with installation instructions.

## 2.03 LOUVERS

- A. Except as otherwise indicated, provide manufacturer's standard louvers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Provide louvers that have minimum free area, and maximum pressure drop of each type as listed in manufacturer's current data, complying with louver schedule.
- C. Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to architectural construction drawings and specifications for types of substrate.
- D. Louvers shall be constructed of aluminum extrusions, ASTM B 221, Alloy 6063-T5. Weld units or use stainless steel fasteners.
- E. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.
- F. Acceptable Manufacturers:
  - 1. Ruskin Manufacturing Company
  - 2. Greenheck Company
  - 3. Louvers and Dampers, Inc.
  - 4. Substitutions under provisions of Division One.

## PART 3 – EXECUTION

- 3.01 All interior surfaces of all air devices shall be painted flat black.
- 3.02 See floor plans for type, neck size and CFM of air for all air distribution devices.
- 3.03 Install all air distribution devices as detailed on plans and in accordance with manufacturer's recommendations.

## END OF SECTION

## **SECTION 15885**

### **AIR FILTERS**

#### **PART 1 - GENERAL**

##### **1.01 GENERAL REQUIREMENTS**

- A. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- B. The Basic Materials and Methods, Section 15050, are included as a part of this Section as though written in full in this document.

##### **1.02 SCOPE**

Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

#### **PART 2 - PRODUCTS**

##### **2.01 FILTERS**

- A. The filters shall be FARR 30/30 2 inch thick or approved equal.
- B. APPROVED MANUFACTURERS: The following manufacturers are approved subject to specification compliance.
  - 1. American Air Filter.
  - 2. Airguard Industries, Inc.
  - 3. Cambridge.

##### **2.02 LOW VELOCITY FILTER SECTION**

- A. Filters shall be of the throwaway cartridge type in 24 inches X 24 inches X 2 inch frames. When installing multiple filters into slide-in frames tape adjacent filters together with duct tape to prevent bypassing of air around the filter. Media shall be rated at 500 feet per minute.
- B. Filtering media shall be formed of non-woven reinforced cotton fabric type filtering media bonded to 96% open area media support grid folded into a non-creased radial pleat design. The filter pack shall be bonded to the inclosing frame to prevent air bypass. Average efficiency shall be 25-30% on ASHRAE test standard 52-76. Initial resistance shall not exceed 0.20 inches water gauge at 350 FPM face velocity.

#### **PART 3 - EXECUTION**

##### **3.01 INSTALLATION**

- A. Install differential pressure switch to activate "Filter Dirty" light when pressure difference across filters reaches 0.5 inch W.G. (adjustable). Locate "filter dirty" lights in mechanical rooms with identifying label
- B. Install and relocate filters in the mechanical or the storage room in accordance with manufacturer's recommendations.
- C. Refer to Section 15050 for additional filter information.

### **END OF SECTION**

**SECTION 15890**  
**METAL DUCTWORK**

**PART 1 - GENERAL**

**1.01 WORK INCLUDED**

- A. Low pressure ductwork.
- B. Casings.
- C. Duct cleaning.

**1.02 RELATED SECTIONS**

- A. Section 09900 - Painting: Weld priming, weather resistant, paint or coating.
- B. Section 15050 - Basic Material and Methods.
- C. Section 15140 - Supports and Anchors.
- D. Section 15290 - Duct Insulation.
- E. Section 15910 - Ductwork Accessories.
- F. Section 15881 - Air Distribution Devices.
- G. Section 15990 - Testing, Adjusting and Balancing.

**1.03 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of metal ductwork products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firms with least 3 years of successful installation experience on projects with metal ductwork systems similar to that required for project.
- C. Codes and Standards:
  - 1. SMACNA Standards: Comply with latest SMACNA's "HVAC Duct Construction Standards, Metal and Flexible" for fabrication and installation of metal ductwork.
  - 2. ASHRAE Standards: Comply with ASHRAE Handbook, Equipment Volume, Chapter 1 "Duct Construction", for fabrication and installation of metal ductwork.
  - 3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems", NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems", and NFPA 96 Standard.
  - 4. IECC 2012: Comply with 2012 International Energy Conservation Code.

**1.04 GENERAL DESCRIPTION**

- A. Extent of metal ductwork is indicated on drawings and in schedules, and by requirements of this section.

## 1.05 SUBMITTALS

- A. Submit shop drawings, duct fabrication standards and product data under provisions of Division One.
- B. Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work.
- C. The contract documents are schematic in nature and are to be used only for design intent. The contractor shall prepare sheet metal shop drawings, fully detailed and drawn to scale, indicating all structural conditions, all plumbing pipe and light fixture coordination, and all offsets and transitions as required to permit the duct to fit in the space allocated and built. All duct revisions required as a result of the contractor not preparing fully detailed shop drawings will be performed at no additional cost.

## 1.06 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain indicated clear size inside lining. Where offsets or transitions are required, the duct shall be the equivalent size based on constant friction rate.
- B. Low Pressure: Three pressure classifications: ½ inch WG positive or negative static pressure and velocities less than 2,000 fpm; 1 inch WG positive or negative static pressure and velocities less than 2,500 fpm, and 2 inch WG positive or negative static pressure and velocities less than 2,500 fpm.
- C. Medium Pressure: Three pressure classifications: 3 inch WG positive or negative static pressure and velocities less than 4,000 fpm, 4 inch WG positive static pressure and velocities greater than 2,000 fpm, and 6 inch WG positive static pressure and velocities greater than 2,000 fpm and;
- D. High Pressure: 10 inch WG positive static pressure and velocities greater than 2,000 fpm.

## 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protection: Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings, use sheet metal end caps on any lined duct exposed to the weather and use 3 mil vinyl wrap with duct tape on end pieces where stored inside.
- B. Storage: Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

## PART 2 - PRODUCTS

### 2.01 DUCTWORK MATERIALS

- A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting.

- B. Sheet Metal.: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lockforming quality, with G 90 zinc coating in accordance with ASTM A 525; and mill phosphatized for exposed locations.
- C. Stainless Steel Sheet: Where indicated, provide stainless steel complying with ASTM A167; Type 316; with No. 4 finish where exposed to view in occupied spaces, No. 1 finish elsewhere. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation.
- D. Aluminum Sheet: Where indicated, provide aluminum sheet complying with ASTM B 209, Alloy 3003, Temper H14.
- E. Ducts shall be constructed and sealed as per the latest SMACNA Duct Construction Standards and as follows:
  - 1. VAV systems - Supply ducts from Air handlers to VAV Boxes constructed to 3" S.P. and Seal Class A.
  - 2. Ducts downstream of VAV boxes constructed to 2" S.P. and Seal Class A.
  - 3. Constant Volume – Supply ducts constructed to 2" S.P. and Seal Class A.
  - 4. Outside/Return/Exhaust ducts constructed to 2" S.P. and Seal Class A.

## 2.02 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Non combustible and conforming to UL 181, Class 1 air duct materials.
- B. Flexible Ducts: Flexmaster U.S.A., Inc. Type 1M or approved equal, corrosive resistant galvanized steel formed and mechanically locked to inner fabric with factory wrapped insulation blanket with aluminum vapor barrier and an R-6 thermal conductance. Flexible duct shall have reinforced metalized outer jacket comply with UL 181, Class 1 air duct. Equivalent manufactures are Thermaflex.
- C. Sealants: Hard-Cast "iron grip" or approved equal, non-hardening, water resistant, fire resistive and shall not be a solvent curing product. Sealants shall be compatible with mating materials, liquid used alone or with tape or heavy mastic.
- D. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
  - 1. For exposed stainless steel ductwork, provide matching stainless steel support materials.
  - 2. For aluminum ductwork, provide aluminum support materials.

## 2.03 LOW PRESSURE DUCTWORK

- A. Fabricate and support in accordance with latest SMACNA Low Pressure Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by approved shop drawings. Obtain engineer's approval prior to using round duct in lieu of rectangular duct.
- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide airfoil-

turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- E. Use crimp joints with bead for joining round duct sizes 6 inch smaller with crimp in direction of airflow.
- F. Use double nuts and lock washers on threaded rod supports.

## 2.04 CASINGS

- A. Fabricate casings in accordance with SMACNA Low Pressure Duct Construction Standards and SMACNA High Pressure Duct Construction Standards and construct for operating pressures indicated.
- B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- C. Reinforce doorframes with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection. Provide clear wire glass observation ports, minimum 6 X 6 inch size.
- D. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gage back facing and 22 gage perforated front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb./cubic foot minimum glass fiber media, on inverted channels of 16 gage.

## PART 3 - EXECUTION

### 3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Obtain manufacturer's inspection and acceptance of fabrication and installation of ductwork at beginning of installation.
- B. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- D. Connect terminal units to medium or high pressure ducts with four feet maximum length of flexible duct. Do not use flexible duct to change direction.
- E. Connect diffusers or troffer boots to low pressure ducts with 6 feet maximum, 4 feet minimum, length of flexible duct. Hold in place with strap or clamp.



- F. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- G. The interior surface of all ductwork shall be smooth. No sheet metal parts, tabs, angles, or anything else may project into the ducts for any reason, except as specified to be so. All seams and joints shall be external.
- H. All ductwork located exposed on roof shall be "crowned" to prevent water from ponding. Ref: Insulation for additional requirements.
- I. Where ducts pass through floors, provide structural angles for duct support. Where ducts pass through walls in exposed areas, install suitable sheet metal escutcheons as closers.
- J. All angles shall be carried around all four sides of the duct or group of ducts. Angles shall overlap corners and be welded or riveted.
- K. All ductwork shall be fabricated in a manner to prevent the seams or joints being cut for the installation of grilles, registers, or ceiling outlets.

### 3.02 INSTALLATION OF FLEXIBLE DUCTS

- A. Determine the minimum length of flexible duct needed for each connection. Excess flex causing tight bends and increased pressure drops are not acceptable. Do not exceed 6'-0" extended length.
- B. Install in accordance with Section III of SMACNA's, "HVAC Construction Standards, Metal and Flexible".
- C. Cut outer vapor barrier and insulation. Fold back insulation and outer vapor barrier to expose inner core. Using sheet metal snips, cut the inner core.
- D. Connect the inner core to the tap or collar by pulling it a minimum of 1" over the collar.
- E. Where collars are less than 1" in length, i.e. diffusers, connect a separate collar to the existing collar and proceed as described in 3.02.C above.
- F. Wrap the core twice with UL181 Tape over the collar. Secure the connection by placing a clamp over the tap or collar, UL listed Panduit clamps for collars with beads and Stainless Steel clamps for collars without beads are acceptable.
- G. Roll the insulation and vapor barrier back over the collar or tap as described in 3.02.C above and wrap twice with UL181 Tape.
- H. Secure the outer vapor barrier with a clamp as described in 3.02.F above if desired.
- I. For Medium to High Pressure applications, use duct sealer for 3.02.F and 3.02.G in lieu of UL181 Tape.
- J. Flexible duct shall be hung with proper support to minimize sagging and snaking between supports. Maximum of 4'-0" between supports. Hanger material will be a minimum of 1 1/2" wide.
- K. Supports will be used before all vertical 90° bends to prevent sagging and ensure a 1.5 center line turn radius of flexible duct.

### 3.03 REQUIREMENTS FOR UNIT CASINGS

- A. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

### 3.04 DUCTWORK APPLICATION SCHEDULE

AIR SYSTEM	MATERIAL
Low Pressure Supply	Galvanized Steel
Return and Relief	Galvanized Steel
General Exhaust	Galvanized Steel
Kitchen Hood Exhaust	Galvanized Steel

### 3.05 DUCTWORK HANGERS AND SUPPORTS

- A. All ductwork shall be properly suspended or supported from the building structure. Hangers shall be galvanized steel straps or hot-dipped galvanized rod with threads pointed after installation. Strap hanger shall be attached to the bottom of the ductwork, provide a minimum of two screws one at the bottom and one in the side of each strap on metal ductwork. The spacing, size and installation of hangers shall be in accordance with the recommendations of the latest SMACNA edition.
- B. All duct risers shall be supported by angles or channels secured to the sides of the ducts at each floor with sheet metal screws or rivets. The floor supports may also be secured to ducts by rods, angles or flat bar to the duct joint or reinforcing. Structural steel supports for duct risers shall be provided under this Division.

### 3.06 DUCT JOINTS AND SEAMS

- A. Seal all non-welded duct joints and seams with duct sealant as indicated. ***“All longitudinal and transverse joints, seams and connections in metallic and non-metallic ducts shall be constructed as per specified in SMACNA HVAC Duct Construction Standards-Metal and Flexible and SMACNA Fibrous Glass Duct Construction Standards or NAIMA Fibrous Glass Duct Construction Standards. All longitudinal and transverse joints, seams and connections shall be sealed in accordance with the International Energy Conservation Code.”***

**END OF SECTION**

**SECTION 15910**  
**DUCTWORK ACCESSORIES**

**PART 1 - GENERAL**

**1.01 WORK INCLUDED**

- A. Volume control dampers.
- B. Round Duct Taps.
- C. Back draft dampers.
- D. Air turning devices.
- E. Flexible duct connections.
- F. Duct access doors.
- G. Duct test holes.

**1.02 RELATED WORK**

- A. Section 15240 - Vibration Isolation.
- B. Section 15890 - Ductwork.

**1.03 REFERENCES**

- A. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- B. SMACNA - Low Pressure Duct Construction Standards.
- C. UL 33 - Heat Responsive Links for Fire-Protection Service.
- D. UL 555 - Fire Dampers and Ceiling Dampers.

**1.04 SUBMITTALS**

- A. Submit shop drawings and product data under provisions of Division One.
- B. Provide shop drawings for shop fabricated assemblies indicated, including volume control dampers duct access doors duct test holes. Provide product data for hardware used.
- C. Submit manufacturer's installation instructions under provisions of Section 01300, for fire dampers and combination fire and smoke dampers.

## PART 2 PRODUCTS

### 2.01 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.
- B. Fabricate splitter dampers of material same gauge as duct to 24 inches size in either direction, and two gauges heavier for sizes over 24 inches.
- C. Fabricate splitter dampers of double thickness sheet metal to streamline shape. Secure blade with continuous hinge or rod. Operate with minimum 1/2 inch diameter rod in self aligning, universal joint, action flanged bushing, with set screw.
- D. Fabricate single blade dampers for duct sizes to 9-1/2 x 24 inch.
- E. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12 x 72 inch.
  - 1. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
  - 2. On outside air, return air, and all other dampers required to be low leakage type, provide galvanized blades and frames, seven inches wide maximum, with replaceable vinyl, EPDM, silicone rubber seals on blade edges and stainless steel side seals. Provide blades in a double sheet corrugated type construction for extra strength. Provide hat channel shape frames for strength and blade linkage enclosure to keep linkage out of the air stream. Construction leakage not to exceed 1/2%, based on 2,000 fpm and 4 inch static pressure.
- F. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- G. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Where rod lengths exceed 30 inches provide regulator at both ends.
- H. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

### 2.02 ROUND DUCT TAPS

- A. Taps to trunk duct for round flexible duct shall be spin-in fitting with locking quadrant butterfly damper, model no. FLD-B03 by Flexmaster or approved equal.

### 2.03 ACCEPTABLE MANUFACTURERS - BACKDRAFT DAMPERS

- A. Greenheck
- B. American Warming and Vent.
- C. Louvers and Dampers Inc.
- D. Ruskin.
- E. Substitutions: Under provisions of Division One.

### 2.08 BACKDRAFT DAMPERS.

- A. Gravity back draft dampers, size 18 x 18 inches or smaller, furnished with air moving equipment, may be air moving equipment manufacturers standard construction.
- B. Fabricate multi-blade, parallel action gravity balanced back draft dampers of 16 gauge galvanized steel, or extruded aluminum, with blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.04 ACCEPTABLE MANUFACTURERS - AIR TURNING DEVICES

- A. Young Regulator.
- B. Titus.
- C. Tuttle and Bailey.
- D. Substitutions: Under provisions of Division One.

2.05 AIR TURNING DEVICES

- A. On duct sizes less than 12 x 12, multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades, mounting straps.
- B. Multi-blade device with radius blades attached to pivoting frame and bracket, steel or aluminum construction, with worm drive mechanism with 18 inch long removable key operator.

2.06 ACCEPTABLE MANUFACTURERS - FLEXIBLE DUCT CONNECTIONS

- A. Metaledge.
- B. Ventglass.
- C. Substitutions: Under provisions of Division One.

2.07 FLEXIBLE DUCT CONNECTIONS TO AIR MOVING EQUIPMENT

- A. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.
- B. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 20 oz per sq yd, approximately 6 inches wide, crimped into metal edging strip.

2.08 ACCEPTABLE MANUFACTURERS - DUCT ACCESS DOORS

- A. Greenheck
- B. American Warming and Vent.
- C. Ruskin.
- D. Titus.

- E. Substitutions: Under provisions of Division One.

## 2.09 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards and as indicated.
- B. Review locations prior to fabrication.
- C. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover. Insulation shall be replaceable without field cutting or patching.
- D. Access doors smaller than 12 inches square may be secured with sash locks.
- E. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.
- F. Access doors with sheet metal screw fasteners are not acceptable.

## 2.10 DUCT TEST HOLES

- A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent test holes shall be factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions.
- B. Balancing Dampers
  - 1. Provide at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts and as required for air balancing. Use splitter dampers only where indicated.
  - 2. All regulators mounted on externally insulated ductwork shall have 16 gauge elevated platforms at least 1/8 inch higher than the thickness of the insulation. Damper shaft shall have Ventlock No. 607 bearing mounted on ductwork within elevated platform. If duct is inaccessible the operating handle shall be extended and the regulator installed on the face of the wall or ceiling. Where regulators are exposed in finished parts of the building, they shall be flush type, Ventlock No. 666. All regulators shall be manufactured by Ventlock, or approved equal.
  - 3. All dampers in lined ductwork shall have bushing to prevent damper damage to liner.
- C. Provide back draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

- D. Provide flexible duct connections immediately adjacent to equipment in ducts associated with fans and motorized equipment. Provide at least one inch slack at all flexible duct connections.
- E. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated.
- F. Provide duct test holes where indicated and required for testing and balancing purposes.

**END OF SECTION**

## **SECTION 15958**

### **AUTOMATIC TEMPERATURE CONTROLS**

#### **PART 1 – GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Complete system of automatic controls.

##### **1.02 GENERAL FUNCTIONS**

- A. The microprocessor based thermostat shall automatically provide occupied and unoccupied setpoints for each zone and scheduling for all connected loads and HVAC equipment.
  - 1. Time-of-Day Scheduling
  - 2. Occupied and Unoccupied Temperature Control Setpoints
  - 3. Timed Override
  - 4. Time and date
  - 5. local Edit Terminal Capability
  - 6. Remote Access

##### **1.03 TYPE OF SYSTEM**

- A. The system shall be composed of an independent, standalone, microprocessor-based thermostat. The thermostat shall communicate with its respective unit and provide for scheduling and coordination of occupied and unoccupied setpoints.

##### **1.04 SUBMITTALS**

- A. Shop Drawings: Indicate operating data, system diagrams, wiring diagrams, and description of operating sequences. Include sizing of components as requested.
- B. Product Data: Provide data for each manufactured component.
- C. Operating and Maintenance Instructions. Include relevant instructions.

##### **1.05 WARRANTY**

- A. Provide warranty under provisions of Division One.

##### **1.06 WIRING**

- A. Refer to Division 16, Electrical. Include all necessary wiring which is not specified under Electrical.

##### **1.07 AS-INSTALLED DRAWINGS**

- A. At completion of job, furnish two copies of corrected wiring diagrams, one enclosed in laminated plastic and mounted on wall of Mechanical Room.

##### **1.08 MANUFACTURER'S ADJUSTMENT**



- A. At completion of job, control manufacturer must submit to the Architect a letter stating that he has final calibrations and adjustments to the system, and that the Owner's operating personnel have been instructed in its use.

## PART 2 – PRODUCTS

### 2.01 ACCEPTABLE SYSTEM MANUFACTURERS

- A. Trane.
- B. Honeywell.
- C. Automated Logic.
- D. Carrier.

### 2.02 BASE UNIT

- A. The thermostat shall consist of a touch screen panel with an LCD display with interactive screen to support security access and simple changing of parameters. Display shall be backling and easy to read.
- B. Power shall be 24V, 50/60 Hz. The control system shall contain its own on-board isolation transformer or a dedicated transformer shall be provided.
- C. Operating temperature range shall be 32°F to 120°F.
- D. Operating humidity range shall be 10% to 90% non-condensing.
- E. Provide clear plastic covers when thermostat is located in public spaces.

### 2.03 AGENCY LISTINGS

- A. The controls system shall be listed by Underwriters Laboratories Inc. for Enclosed Energy Management Equipment under UL #916.
- B. The building control panel shall comply with Federal Communications commission (FCC) Regulation, Part 15, Subpart J, for Class A computing devices.
- C. All wiring shall be in accordance with the National Electrical Code and all Local electrical codes.

### 2.04 SOFTWARE

- A. Software Integrity – All schedules and setpoints shall be resident in EEPROM. The clock function shall be maintained for a minimum of 250 hours at up to 140°F on power loss.
- B. The local display shall prompt the infrequent user for setup and/or adjustment of:
  - 1. The system time and date
  - 2. Heating and cooling, occupied and unoccupied setpoints
  - 3. Monitoring temperatures, operating modes, on/off statuses and failure conditions
  - 4. Holiday and Exception dates
  - 5. Units of temperature
  - 6. Daylight Savings Time
  - 7. Filter changes

- C. Time-of-Day Scheduling – Each device shall be able to have a separate schedule with two on and two off events per day. The panel shall be capable of optimally starting the HVAC units based on individual unit recovery ramps.

Time-of-Day scheduling shall be continuous, such that if power is lost, on power-up the panel will look back for each device to see whether it should be on/off or in occupied/unoccupied temperature setpoints. If necessary, the software will look back at the previous day's schedules to determine the desired state of each device/zone.

- D. Holiday Schedules – Each connected binary output and each connected unit shall have nine different daily schedules: Monday through Sunday, Holiday, and Exception days. The thermostat shall provide a minimum of 24 Holidays per year.
- E. Timed Override – Each scheduled device shall be able to be overridden at the system keypad to the occupied mode for up to two hours. The override shall also be cancelable from the local keypad at any time during the override.
- F. Daylight Savings Time – The system panel software shall automatically update time according to daylight savings at the legislated time and date and reset time at the end of the daylight savings period. This function shall be able to be disabled.
- G. Temperature Units – All temperature inputs connected directly to the system panel or communicating over the communications link shall be able to display temperature inputs in degrees Fahrenheit or in degrees Centigrade, selectable from the front keypad.
- H. Multiple Languages – The main panel shall support two additional languages other than the English language.
- I. Security – Upon initial start up the factory security level shall secure the building control panel from each of the following local capabilities: changing time and date, changing setpoints, changing schedules, and initiating timed override. The security password shall be provided in the installation manual.
- J. Expansion – The ability to add additional HVAC units without any additional hardware at the small building control panel.

## 2.05 DX /SPLIT SYSTEM UNIT CONTROLS

- A. The thermostat shall be capable of communicating with its respective rooftop/split system.
- B. The thermostat shall be capable of monitoring and communicating the following information:
  - 1. Analog input Points
    - a. Supply air temperature
    - b. Zone temperature
    - c. Active setpoint
  - 2. Binary Input Points
    - a. Smoke/fire alarm status
    - b. Supply fan on/off status
    - c. Dirty filter

3. The thermostat shall provide the following control functions:
  - a. Fan on or off
  - b. 1<sup>st</sup> stage cooling on or off
  - c. 2<sup>nd</sup> stage cooling on or off
  - d. 1<sup>st</sup> stage heating on or off
  - e. 2<sup>nd</sup> stage heating on or off
  - f. Occupied setpoint
  - g. Unoccupied setpoint

**END OF SECTION**

**SECTION 15990**  
**TESTING, ADJUSTING, AND BALANCING**

**PART1- GENERAL**

**1.01 GENERAL REQUIREMENTS**

- A. Conditions of the contract and general requirements in Division 1 apply to work specified in all section of Division 15.
- B. All Division 15 specification sections, drawings, and general provisions of the contract apply to work of this section, as do other documents referred to this section.
- C. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- D. Requirements for submittals, shop drawings, and substitutions, Division 1, Section 01300 and 01600, apply to work specified in all sections of Division 15.
- E. The basic Materials and Methods, Section 15050, are included as a part of this Section as though written in full in this document.

**1.02 REFERENCES AND STANDARDS**

- A. The publications listed below from a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

**ASSOCIATED AIR BALANCE CONCIL (AABC)**

(2002) National Standards for Testing Adjusting Balancing of  
Environmental Systems

**NATIONAL EVROMENTAL BALANCING BUREAU (NEBB)**

(1998) National Standards for Testing Adjusting Balancing of  
Environmental Systems

(1994) Procedural Standards for the Measurement and Assessment of  
Sound and Vibration

- B. TAB shall be preformed in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC or NEBB procedural standards, unless otherwise specifies herein. All recommendations and suggested practices contained in the TAB standard shall be considered mandatory. The provisions of the TAB Standard, including checklists, report forms, etc. Shall, as nearly as practical, be used to satisfy the Contract requirements. The TAB standard shall be used for all aspects of TAB, including qualifications, for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, the manufacture's recommendations shall be adhered to. All quality assurance provisions of the TAB Standard such as performance guarantees shall be part of this contract. For systems or system components not covered in the TAB standard TAB procedures shall be developed by the TAB

Specialist. Where new procedures, requirements, etc. applicable to the Contact requirements have been published or adopted by the body responsible for the TAB Standard used (AABC or NEBB), the requirements and recommendations contained in these procedures and requirements shall be considered mandatory.

- C. The TAB contractor shall submit all questions regarding interpretations and questions regarding these standards in writing or as required by documents to the A/E team who shall provide formal reply in ka reasonable time. Decisions of the A/E team shall be final.

#### 1.03 DEFINITIONS AND SIMILAR TERMS

- A. In some instances, terminology differs between the Contract TAB Standard primarily because the intent of this section is to use the industry standards specified, along with the additional requirements listed herein to produce optimal results. The following table of similar terms is provided for clarification only. Contract requirements take precedent the corresponding AABC or NEBB where differences.

<u>CONTRACT TERM</u>	<u>AABC TERM</u>	<u>NEBB TERM</u>
TAB Standard	National Standard Testing and Balancing Heating, Ventilating, and Air Conditioning System	Procedural Standards for Testing Adjusting Environmental System
TAB Specialist	TAB Engineer	TAB Supervisor
System Readiness Check	Construction Phase Inspection	Field Readiness Check & Preliminary Field Procedures

#### 1.04 QUALIFICATIONS

- A. The TAB of the air conditioning systems will be performed by an independent, impartial technical firm whose operations are limited only to the field of professional TAB, and is not a part or subsidiary of any other project contractor or subcontractor, to include, but not limited to General Contractor, and Mechanical; Contractor. The TAB work will be done under the direct supervision of qualified Professional Engineer employed as a full time employee of TAB firm.
- B. The TAB agency shall be either a member of AABC or certified by the NEBB and certified in all categories and functions where measurements or performance are specified on the plans and specifications.
- C. QUALIFICATIONS OF CONTRACTOR PERSONAL: Submit evidence to show that the people who shall be in charge of correcting deficiencies for balancing the systems are qualified. The Owner and Engineer reserve the right to require that the originally approved personal be replaced with other qualified personnel if, in the Owner and Engineer's opinion, the original personnel are not qualified to properly place the system in condition for balancing.
- D. QUALIFICATIONS OF TAB FIRM

The certification shall be maintained for the entire duration of specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor shall immediately execute each certifying agency's applicable Performance Guaranty, then immediately notify the Contracting Officer and submit another TAB firm for approval, at no additional cost to Project Owner, Architect, Engineer, or their designated representatives. Any firm that has been the subject to disciplinary action by either the AABC or the NEBB within the five years preceding the contract award shall not be eligible to perform any duties related to the HVAC systems including TAB. All work specified in this section and in other related sections to be performed by the TAB firm shall be considered invalid if the TAB firm loses its certification prior to contract completion and must be performed by an approved successor, at no additional cost to Project Owner, Architect, Engineer, or their designated representative. The TAB firm shall have an occupied office within 100 miles of the project site.

E. QUALIFICATIONS OF TAB FIRM PERSONAL:

1. A minimum of one registered Professional Engineer, licensed in the State the work is performed, is required to be in permanent employment of the firm.
2. The TAB Specialist shall be either a member of AABC or an experienced technician of the firm certified by NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason the Specialist loses subject certification during this period, the Contractor shall immediately execute each certifying agency's applicable Performance Guaranty, then immediately notify the Contracting Officer and submit another TAB Specialist for approval, at no additional cost to Project Owner, Architect, Engineer, or their designated representatives. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding the contract award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this section and other related sections to be performed by the TAB Specialist shall be considered invalid if the TAB Specialist loses certification prior to the contract completion and must be performed by an approved successor, at no additional cost to the Project Owner, Architect, Engineer, or their designated representatives.
3. Personnel used on the job site shall be either Professional Engineers or technicians, who shall have been permanent, full time employees of the firm for a minimum of six months prior to the start of work for that specified project.
4. Evidence shall be submitted to show that the personnel who actually balanced the systems are qualified. Evidence showing that the personnel have passed the tests required by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) shall be required.

F. ACCEPTABLE TAB FIRMS SHALL INCLUDE:

1. Engineering Air Balance Company (210-736-9494)
2. PHI Service Agency (956-464-1234)

3. Testing Specialties (210-492-8885)
4. Professional Engr. Balance Lab (210-828-6622)

#### 1.05 SCOPE OF WORK

- A. The General (Prime) Contractor will contract with a professional TAB firm under the provisions of paragraph 1.04 of this section.
- B. The TAB firm will be responsible for inspecting, adjusting, balancing, and logging the data on the performance of fans, dampers in the duct system, and air distribution devices. The Contactor and the various subcontractors of the equipment installed shall cooperate with the TAB firm to furnish necessary data on the design and proper applications of the system components and provide labor and material required to eliminate deficiencies or poor performance.
- D. The work included in this section consists of furnishing labor, instruments, and tools required in testing, adjusting, and balancing the HVAC systems, as described in these specifications or shown on accompanying drawings. Services shall include checking equipment performance, taking specified measurements, recording and reporting the results. The items requiring testing, adjusting, and balancing include the following (as applicable to contract drawings):

##### AIR SYSTEMS

Air Handling Units  
Exhaust Fans  
Diffusers, Registers, & Grilles  
Coils (Air Temperature)

#### 1.06 SUBMITTALS AND RELATED DOCUMENTS:

- A. The name of the selected AABC or NEBB certified firm shall be submitted to the Engineer for approval within 30 days after contract award.
- B. Within 30 days after the award of contract, the TAB firm shall submit for approval an organizational chart and proof of current certification which shall identify all AABC or NEBB certified Supervisors or Specialist. The TAB firm shall submit a company resumes listing personal and project experience in air and hydronic system balancing. TAB firm will also provide information showing successful completion for three similar scope projects for which the firm is being contracted.
- C. Within 30 days after the award of contract, the TAB firm will submit for approval the name of the TAB Specialist and/or Professional Engineer, who will have direct supervision of all TAB related labor through completion of project.
- D. Within 30 days after the award of contract the TAB firm shall submit TAB procedures and agenda proposed to be used.
- E. Within 30 days after the award of contract, but prior to TAB field measurements, the TAB firm shall submit sample report forms, sample report forms, which shall include minimum data required by either the AABC or NEBB National Standards.

- F. Within 15 days of notification of approval of TAB firm and TAB Specialist by engineer, TAB firm shall conduct a Design Review of contract drawings and submit a Design Review report.
- G. Proposed date and time for execution of Systems Readiness Inspection shall be submitted no later than 7 days prior to inspection. A copy of the Systems Readiness Inspection Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.
- H. Proposed date and time to begin field measurements, making adjusting, ext., for the TAB report, shall be submitted with the Systems Readiness Inspection Report.
- I. Six (6) copies of the completed TAB Report shall be submitted for approval no later than 7 days after the execution of TAB. All copies of TAB Report shall be signed by the TAB Specialist and shall bear the seal of the Professional Society or National Association used as the TAB Standard.
- J. Proposed date and time to begin TAB Completion Verification, shall be submitted with the TAB Report. Six (6) copies of TAB Completion Verification Report shall be submitted no later than 7 days after execution of TAB verification.
- K. Proposed date and time for execution of Opposite Season Inspection shall be submitted no later than 7 days prior to inspection.

#### 1.07 INSTRUMENTATION

- A. All instruments used for measurements shall be accurate and calibrated. TAB firm shall submit list of all instruments, to include gauges, thermometers, flow measuring hoods, and other balancing devices to be used in balancing the system. The list will indicate name of equipment, function, model number, serial number, date of the last calibration, and date calibration is due. TAB firm shall submit copies of calibration certificates for all test instruments used showing all devices were properly calibrated before proceeding with system balancing. All instruments will be within one year of calibration for duration of the project. If duration of project exceeds the tenure of instrument calibration, then said instrument must be recalibrated, and copy of calibration certificate sent to Engineer, before the instrument is placed into continued use.

#### 1.08 TAB PREPARATION AND COORDINATION

- A. It is the intent of this specification section to provide for a completely tested, adjusted, and balanced (TAB) installation without overlaps or omissions between the installing contractor and the TAB contractor. The installing contractors are those who perform the installation of this work and make all preparations for the TAB contractor who performs the testing, adjusting, and balancing described herein.
- B. The contractor Manager or General Contractor performing the General construction work shall coordinate the work of the contractors performing the Mechanical, Electrical, Automatic Temperature Control, and TAB work to provide complete properly tested, adjusted, and balanced systems. The Construction Manager or General Manager shall require and provide a start-up report for each piece of equipment furnished.
- C. The contractor performing the HVAC work shall coordinate all Mechanical work, including Sheet Metal work and Automatic Temperature Controls, to provide a



complete, properly tested adjusted and balanced system throughout. He shall furnish progress reports regarding this phase of the work on a regular basis as directed. At such time as the systems are started up, the Contractor performing the Mechanical work shall provide TAB Contractor with documentation that the duct systems have been tested to the satisfaction of the Duct Leak Test Specifications. The Mechanical Contractor shall insure that all comments are installed and operating, and the major components such as fans, pumps, refrigeration machines, and the like are capable of producing the scheduled capacity requirements. The requirement does not relieve the Mechanical Contractor of any other requirements specified elsewhere. Should any of these components or systems not be capable of producing these requirements, he shall make corrections within the limits of his responsibility or as otherwise authorized and shall certify in writing that the systems are ready for final testing and balancing by the Tab contractor.

- D. The contractor performing the Electrical work shall work coordinate all electrical work to provide complete, properly tested, adjusted and balanced mechanical systems throughout the project. He shall furnish progress reports on a regular basis as directed. He shall certify in writing when each system is electrically operable, including the check for proper rotation of equipment.
- E. The Contractor performing the Automatic Temperature Controls work shall coordinate all controls work to provide complete, properly tested, adjusted and balanced mechanical systems throughout the project. He shall furnish progress reports on a regular basis as directed. He shall certify in writing when each system is operational from an Automatic Temperature Controls standpoint. This contractor shall also provide to TAB contractor all necessary submittal information, software, and/or personal complete, properly tested, adjusted and balanced mechanical systems.
- F. The TAB contractor shall from the award of contract, begin preparation.

## **PART 2-PRODUCTS (NOT USED)**

## **PART 3- EXECUTION**

### **3.01 SERVICES OF THE CONTRACTOR**

- A. The drawing and specifications have indicated valves, dampers, and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, install these devices in a manner that leaves them accessible, provide access as requested by the TAB firm.
- B. Have systems complete and in operational readiness prior to notifying the TAB firm the project is ready for their services, and certify in writing to the Construction Manager that such a condition exists.
- C. As a part of the Work of this Section, make changes in the sheaves, belts, and dampers or the addition of dampers required for correct balance of new work as required by TAB firm, at no additional cost to owner.
- D. Fully examine the existing system to be balanced, to determine, whether or not sufficient volume dampers, balancing valves, thermometers, gauges, pressure in the duct systems, means of determining water flow, and other means of taking data needed for proper water and air balancing are existing. Submit to the Engineer in

writing a listing of omitted items considered necessary to balance existing systems. Submit the list and proposal as a cost add item.

- E. Verify that fresh air louvers are free of blockage, coils are clean and fresh air ducts to each air handling unit has individually adjustable volume regulating dampers.
- F. Provide correct, repair, or replace deficient items or conditions found during the testing, adjusting, and balancing period.
- G. In order that systems may be properly tested, balanced, and adjusted as specified, operate the systems at no expense for the Owner at the length of time necessary to properly verify their completion and readiness for TAB period.
- H. Project Contract completion schedules shall allow time for allowance to permit the successful completion of TAB services to Owner's final inspection and expectance. Complete, operational readiness, prior to commencement of TAB services, shall include the following services of the Contractor:
  - 1. Construction status of building shall permit the closing of doors, window, ceilings, installed and penetrations complete, to obtain project operating conditions.
  - 2. AIR DISTRIBUTION SYSTEMS:
    - a. Verify installation for conformity to design. Supply, return, and exhaust ducts terminated and pressure tested for leakage as specified.
    - b. Volume and fire dampers properly located and functional. Dampers serving requirements of minimum and maximum outside air, return and relief shall provide tight closure and full opening, smooth and free operation.
    - c. Supply return, exhaust and transfer grilles, registers and diffusers.
    - d. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, ect., shall be blanked and sealed to eliminate excessive bypass or leakage of air.
    - e. Fans (supply and exhaust) operating and verified for freedom from vibrations, proper fan rotation and belt tension; overload heater elements shall be of proper size and rating ; record motor amperage and voltage and verify that these functions do not exceed nameplate ratings.
    - f. Furnish or revise fan drives or motors as necessary to attain the specified air volumes.
  - 3. AUTOMATIC CONTROLS
    - a. Verify that control components are installed in accordance with project documents and functional, electrical interlocks, damper sequences, air and water resets, fire and freeze stats.
    - b. Controlling instruments shall be functional and set for design operating conditions. Factory pre-calibration of room thermostats and pneumatic equipment will not be acceptable.
    - c. The temperature shall be regulation shall be adjusted for proper relationship between the controlling instruments and calibrated by the TAB Contractor. Advise Owner of deficiencies or malfunctions.

### 3.02 SERVICES OF THE TAB FIRM

- A. The TAB firm will act as liaison between the Owner, Engineer, and Contractor and inspect the installation of mechanical piping system, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating

systems being retrofitted, repaired, or added under this Contract. The re-inspection of the Work will cover that part related to proper arrangement and adequate provision for the testing and balancing and will be done when the Work is 80 percent complete.

- B. Upon completion of the installation and start –up of the mechanical equipment, to check, adjust, and balance system components to obtain optimum conditions in each conditioned space in the building. Prepare and submit to the Owner complete reports on the balance and operations of the systems.
- C. Measurements and recorded readings of air, water and electricity that appear in the TAB reports will be done by the permanently employed technicians or engineers of the TAB firm.
- D. Make an inspection in the building during the opposite season from that in which the initial adjustments were made. At the time, make necessary modifications to the initial adjustments required to produce optimum operation of system components to effect the proper conditions as indicated on the Drawings. At time of opposite season check-out, the Owner's representative will be notified before readings and adjustments are made.
- E. In fan systems, the air quantities indicated on the Drawings may be varied as required to secure a maximum temperature variation of two degrees with each separately controlled space, but the total air quantity indicated for each zone must be obtained. It shall be the obligation of the Contractor to furnish or revise fan drive and motors if necessary, without cost to the Owner, to attain the specified air volumes.
- F. The various existing water circulating systems shall be cleaned, filled, purged, of air, and put into operation before hydronic balancing.

### 3.03 PROFESSIONAL REPORT

- A. Before the final acceptance of the report is made the TAB will furnish the Owner the following data to be approved by the Owner and Engineer.
  - 1. Summary of main supply, return and exhaust duct pilot tube traverses and fan settings indicating minimum value required to achieve specified air volumes.
  - 2. A listing of the measured air quantities at each outlet corresponding to the temperature tabulation as developed by the Engineer and TAB firm.
  - 3. Air quantities at each return and exhaust air handling device.
  - 4. Static pressure readings entering and leaving each supply fan exhaust fan, filter, coil, balancing dampers and other components of the systems included in the retrofit Work. These readings will be related to performance curves in terms of the CFM handled if available,
  - 5. Motor current readings at each equipment motor on load side of capacitors. The voltages at the time of the reading shall be listed.
  - 6. The final report shall certify test methods and instrumentation used, final velocity reading obtained, temperatures, pressure drops, RPM of equipment, amperage of motors, air balancing problems encountered, recommendations and uncompleted punch list items. The test results will be recorded on standard forms.
  - 7. A summary of actual operating conditions shall be included with each system outlining normal and ventilation cycles of operation. The final report will act as a reference of actual operating conditions for the Owner's operating personal.

### 3.03 BALANCING AIR CONDITIONING SYSTEM

#### A. GENERAL

1. Place all equipment into full operation, and shall continue the operating during each working day of balancing and testing. If the air conditioning system is balanced during OFF-Peak cooling seasons Balancing Contractor shall return to rebalance air side system as required to put system in proper balance at that time.
2. The contractor shall submit detailed balancing and recording forms for approval. After the approval by the Architect, prepare complete set of forms for recording test data on each system. All Work shall be done under the supervision of Registered Professional Engineer. All instruments used shall be accurately calibrated to within 1% of scale and maintained in good working order.
3. Upon completion of the balancing and testing, the Balancing Contractor shall compile the test data in report forms, and forward five copies to the Architect for evaluation
4. The final report shall contain logged results of all tests, including such data as
  - a. Tabulation of air volume at each outlet.
  - b. Outside dry bulb and wet bulb temperature.
  - c. Inside dry bulb and wet bulb temperature in each conditioned space room or area.
  - d. Actual fan capacities and static pressures. Motor current and voltage readings at each fan.

#### B. AIR SYSTEMS: Perform the following operations as applicable to system balance and test:

1. Check fan rotation.
2. Check filters (balancing shall be done with clean filters).
3. Test and adjust blower rpm to design requirements.
4. Test and record motor full load amperes.
5. Test and record system static pressures, suction and discharge.
6. Test and adjust system for design cfm, return air and outside air (+5%). Change out fan sheaves as required to balance system.
7. Test and record entering air temperatures, db and wb.
8. Test and record leaving air temperature, db and wb
9. Adjust all zones to design cfm (+5%).
10. Test and adjust each diffuser, grille, and register to within 5% of design.

#### D. DX SYSTEMS:

1. Test and record suction and discharge pressures at each compressor and record ambient air temperature entering the condensing coils.
2. Test and record unit full load amps and voltage.
3. Test and record staging and unloading of unit required by sequence of operation or drawing schedule.

#### E. Automatic temperature controls shall be calibrated and all thermostats and dampers, adjusted so that the control system is in proper operating condition, subject to approval of the Architect.

#### F. The Air Balance Contractor shall report to Engineer all air distribution devices or other equipment that operate noisily so that corrective measures may be implemented by the Contractor at no additional cost to the owner.

### END OF SECTION

## **SECTION T-16010 ELECTRICAL GENERAL PROVISIONS**

### **PART 1 GENERAL**

#### **1.01 SCOPE:**

- A. The Contractor shall execute all work as hereinafter specified, as shown on the drawings or as necessary to provide complete and functioning systems. All items of labor, material or equipment not required in detail by the specifications or drawings, but incidental to or necessary for the complete installation and proper operation of all phases of work described herein, or reasonably implied in connection therewith, shall be furnished as if called for in detail by the specifications or drawings.

#### **1.02 LAWS AND ORDINANCES:**

- A. All work and materials shall conform to the requirements of the federal, state, and local laws and ordinances having jurisdiction at the jobsite. The installation shall be in strict accordance with the latest edition of the National Electrical Code (NEC). The Contractor at no increase in contract price shall make all modifications to the work, which may be required by an authority having legal jurisdiction over the work.

#### **1.03 LICENSES, FEES AND PERMITS:**

- A. The Contractor shall have a Master Electrician license issued by or acceptable to the city in which the work is to be performed. Additionally, and at all times while work is being performed, for every five or less craftsman working on the project site, at least one craftsman shall have a Journeyman Electrician license issued by or acceptable to the city in which the work is to be performed. A city electrical construction permit will be required for this project.

#### **1.04 THE DRAWINGS AND SPECIFICATIONS:**

- A. The drawings and specifications shall be interpreted together, and any and all work included in either, though not in both, shall be part of the contracted work. The drawings are diagrammatic but shall be followed as closely as actual construction of the project and existing job site conditions will permit. Any changes due to equipment supplied, conflict with the work of other trades or to make this work conform to the National Electrical Code shall be made by the Contractor at no increase in contract price.

#### **1.05 SITE CONDITIONS:**

- A. Before submitting his bid, the Contractor shall visit the site and familiarize himself with all existing conditions and his bid shall be based on accepting conditions as they exist.

#### **1.06 MATERIALS AND EQUIPMENT:**

- A. All materials and equipment furnished by the Contractor shall be new. Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such materials and equipment. Where two or more units of the same item are required, they shall be products of a single manufacturer. The Contractor shall unload and properly store all electrical materials and equipment delivered to the jobsite.

#### 1.07 UTILITY CONNECTIONS AND SERVICE:

- A. The Contractor shall make arrangements for connection with the electrical utility company that will serve the jobsite and shall comply with all the rules, regulations and requirements of the utility company. The Contractor shall examine the site, confer with the utility company and verify the requirements for connections prior to bidding the work. The Contractor shall verify with the utility company the exact location of service tie-in points, cable routes, etc. Failure of the Contractor to contact the utility company and obtain such information prior to bidding the work shall not be considered as a basis for additional compensation. Where outages to existing electrical service are required, the Contractor shall coordinate the timing and duration of such outages with Owner's representative.
- B. The Contractor shall furnish and install a meter enclosure for the utility company meter. The enclosure and installation shall be in accordance with utility company requirements.

#### 1.08 SAFETY:

- A. It shall be the responsibility of the electrical Contractor to initiate, maintain, and supervise all safety precautions required by local, state, and federal laws, including OSHA.

#### 1.09 SUBMITTALS:

- A. Submittals for Approval:
  - 1. Submit in accordance with Section 01300 except as otherwise stated herein.
  - 2. Within 30 calendar days after award of contract, the Contractor shall furnish seven (7) sets of drawings and data as described herein for Engineer approval. No item of equipment or material shall be ordered or shipped to the job site until the Engineer has given written approval of the submittal data.
  - 3. The submittal data shall be bound in a 3-ring binder with dividers. The binder shall include a cover and a table of contents with the contractors name as well as the name of the project. All data shall be divided by specification section.
  - 4. The submittal data for each item shall include descriptive literature, performance data, shop drawings technical literature and any other necessary data to readily identify that the equipment will meet the requirements of the drawings and specifications.
  - 5. One complete submittal of drawings and data shall be made for all required items. Partial or incomplete submittals will be returned without comment. All copies furnished shall be manufacturer's original copies of good quality,

legible photocopies or blue line prints. **Copies transmitted by facsimile machine are not acceptable.**

6. Submittal documents shall be job specific. Where manufacturer's standard drawings or catalog sheets are provided, they shall be marked to show specifically what is being furnished. Drawings shall be marked to show Owner's name, plant location, project description and equipment designation.
7. Substitutions for specified products shall be in compliance with Paragraph 1.10.
8. The Contractor shall review all manufacturers' submittals for completeness, accuracy and compliance with project specifications before submitting to Engineer.
9. The Engineer will review the complete submittal package and return five (5) sets to the Contractor with individual items marked in one of the following three forms:

Reviewed as submitted  
Reviewed with comments  
Disapproved

Items that are disapproved shall be corrected as required and shall be resubmitted to the Engineer for approval.

- B. Approval of submittals, etc. shall not be construed as releasing the Contractor from further responsibility, but rather as a means to coordinate the work and to aid in the proper selection and installation of the materials and equipment. All materials and equipment shall be subject to final acceptance by the Engineer at completion of the project.

- C. Submittal of Record Data:

1. Record Data: Provide seven (7) sets of record data books containing information listed below. The material shall be bound into appropriately sized 3 ring binders, organized with dividers and index sheets. The binders shall be appropriately labeled with the Owner's name, project name and location. The data books shall include:
  - a. Certified as-built shop drawings for all fabricated equipment.
  - b. Approved product data for all items required in Paragraph 1.09A.
  - c. Spare parts lists
  - d. Test records.
2. Record Drawings: Provide one (1) set of project drawings marked neatly and legibly in colored pencil to show any significant deviation between actual conditions and original design layout.
3. Operation and Maintenance Data: Provide seven (7) sets of manufacturer's operation and maintenance data on equipment and components. The data shall be organized into loose-leaf binders with dividers and master index.

#### 1.10 SUBSTITUTIONS:

- A. Requirements for Substitutions: It is the intention of the drawings and specifications to establish a definite standard when a particular manufacturer's product is mentioned. Written request for substitutions of equivalent products will be considered provided all the following conditions are met. Substitutions for specified products will not be permitted unless all of the following conditions are met:
1. Written request shall be received in the Engineer's office ten (10) days prior to the day of bid opening. Requests after ten days prior to the day of bid opening will not be considered.
  2. Request shall include complete technical data, i.e. product data sheets, curve, ratings, etc.
  3. Request shall include a complete written comparison of differences and similarities between the proposed and specified product. Provide a written comparison for each substitution being requested.
  4. Space and clearance requirements are adequate for products mentioned. It is the responsibility of the Contractor to verify space and clearance requirements for products proposed for substitution.
  5. If modifications to the drawings and specifications are necessary for the proper installation of a product proposed for substitution, the request shall explain such in detail, accompanied by drawings if necessary.
- B. Approval: If the above has been complied with, and in the Engineer's opinion the product proposed for substitution is equivalent to that mentioned, the product will be approved for substitution and all prospective bidders will be so notified.

#### 1.11 PROTECTION:

- A. All new work, equipment and materials shall be protected at all times to prevent damage or breakage, either in transit, storage, installation or testing. All openings shall be closed with caps or plugs during installation. All materials and equipment shall be covered and protected against dirt, water, chemical or mechanical injury. This shall include the erection of all required temporary shelters, cribbing of any apparatus above floor construction and covering of apparatus in incomplete buildings with tarpaulins or other protective covering. Temporary electric heaters shall be installed to keep apparatus dry. All rotating equipment and/or machinery shall be properly lubricated and rotated on a regular basis. All electrical materials and equipment damaged during handling, storage, and installation, until the Owner has accepted the project, shall be repaired or replaced by the Contractor with no increase in contract price.

#### 1.12 COORDINATION:

- A. The Contractor shall not hinder and/or delay any work being accomplished by other construction companies at or near the general construction site; nor shall



the Contractor impede normal operation of the Owner at any time except as otherwise indicated.

1.13 WORKMANSHIP:

- A. All labor shall be performed in the best and most workmanlike manner by mechanics skilled in their particular trades. All installations shall be complete in both effectiveness and appearance whether finally enclosed or left exposed. The Engineer reserves the right to direct the removal or replacement of any item which, in his opinion, does not present a reasonably neat or workmanlike appearance, providing that same can be properly installed in an orderly way by usual methods for such work. All specialties and appurtenances shall be installed to conform to the manufacturer's recommendations unless otherwise specified.

1.14 EQUIPMENT BY OTHERS:

- A. This Contractor shall make electrical connections to equipment installed by other trades. The mechanical contractor shall install all motor driven equipment and motors furnished under this contract.
  - 1. The Contractor shall verify the electrical requirements of equipment and appliances furnished by others with data provided by the successful vendor or vendors. The Contractor shall provide the proper sized circuits, circuit breakers, starters, disconnect switches, receptacles, etc. as required to connect this equipment. If changes are required to electrical systems shown on the drawings, the Contractor shall make these changes at no additional cost to Owner.

1.15 CUTTING AND REPAIRING:

- A. The Contractor shall coordinate the work to eliminate cutting of the construction except as specified. Where it becomes necessary to cut through the construction to permit the installation of work or the repair of defective work, it shall be done by mechanics skilled in the trade of erecting the type of work involved. The Contractor without additional compensation shall pay the cost of cutting and repairing. No cutting shall be done to any structural members unless the Engineer grants specific permission, in writing.

1.16 SLEEVES, INSERTS, SUPPORTS, ANCHOR BOLTS, FLASHING AND FOUNDATIONS:

- A. Furnish and install all sleeves, inserts, supports, anchor bolts, flashing, counter flashing and foundations required for the proper installation of the proposed work.

1.17 CLEANING:

- A. All debris resulting from the construction shall be removed from the project site daily. Upon completion of the project, unused materials and equipment shall be removed from the project site. All visible labels, dirt overspray, paint, grease,

and stains shall be removed from all electrical equipment. Labels indicating testing laboratory approval or giving parts numbers shall be left in place.

1.18 TESTING:

- A. The Contractor shall test the entire wiring system for proper voltage level and balance, and for short circuits and grounds in accordance with established methods upon completion of work. The system shall operate satisfactorily in every respect. This Contractor shall make all corrections to accomplish such.

1.19 INSPECTIONS:

- A. The Contractor shall cooperate with and provide assistance to the Engineer or the Engineer's Inspector in making periodic and final inspections of the work. This assistance shall include, but not necessarily be limited to, the furnishing of labor, tools, etc. to operate equipment and demonstrate its proper functioning. Also included shall be the removal of outlet, junction box and panel covers, etc. as necessary for the Engineer to inspect the work.

1.20 GUARANTEE:

- A. Any defects from imperfect or improper materials or faults arising from improper workmanship that may appear within a period of twelve (12) months from the date of final acceptance of the system shall be amended and made good by the Contractor at his own cost. Any defects or faults shall be attended to within ten (10) days after receiving written notice from the Engineer. Failure to promptly attend to said defects or faults shall be sufficient cause for the Owner to correct the problem with the Owner's forces or the forces of others and invoice the Contractor for any and all charges, including management and overhead, related to correcting said problem.

END OF SECTION

## **SECTION T-16060 GROUNDING**

### **PART 1 GENERAL**

#### **1.01 SUMMARY:**

##### **A. Section Includes:**

1. Solid grounding of electrical systems, equipment, machine frames, enclosures, appliances and structures.
2. Basic requirements for grounding for protection of life, equipment, circuits, and systems.
3. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

#### **1.02 REFERENCES:**

##### **A. American Society for Testing and Materials (ASTM):**

1. B3 Standard Specification for Soft or Annealed Copper Wire.
2. B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
3. B33 Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

##### **B. National Fire Protection Association (NFPA):**

1. 70 National Electrical Code
2. 78 Lightning Protection Code

##### **C. Underwriters Laboratories Inc. (UL)**

1. 467 UL Standard for Safety Grounding and Bonding Equipment.

#### **1.03 SUBMITTALS – FOR APPROVAL:**

##### **A. Procedure: Submit in accordance with Section 01300 and 16010.**

##### **B. Product Data: Submit for grounding conductors, ground rods, clamps, connectors, wells and insulating materials.**

1.04 SUBMITTALS – RECORD DATA:

- A. Submit in accordance with Section 01300.
- B. Product Data: Approved, as furnished data as listed above.
- C. Test Reports

1.05 QUALITY ASSURANCE:

- A. Items provided under this Section shall be listed or labeled by UL.
- B. Regulatory Requirements:
  - 1. National Electrical Code (NEC): Provide components and installation as required by National Fire Protection Association (NFPA) 70, Article 250.

PART 2 PRODUCTS

2.01 GENERAL:

- A. Provide products in quantities, sizes and ratings to comply with the NEC or the design drawings, whichever requirements are more stringent.
- B. Conductor Materials: Copper
- C. Connector Materials: Copper or bronze, tin-plated where required for corrosion resistance.

2.02 CONDUCTORS:

- A. Grounding Electrode Conductor: Soft drawn copper, Class B stranded per ASTM B-8, 600 volt TW, THW or THWN insulation. Size per NEC 250.
- B. Equipment Grounding Conductor: Soft drawn copper, Class B stranded per ASTM B-8 except that conductor sizes Nos. 12 and 10 AWG used in lighting and receptacle branch circuits may be solid conductor. All conductors shall have 600 volt, TW, THW or THWN insulation.
- C. Grounding Grid Conductor: Medium hard drawn bare copper, Class B stranded per ASTM B-8, No. 2/0 AWG or as otherwise indicated on the drawings.
- D. Color Code: Insulation color shall be green, except that sizes No. 2 AWG and larger may be black with green colored tape spirally applied over all visible surfaces within enclosures.

2.03 WIRE CONNECTORS:

- A. Terminal Lugs: Copper alloy, tin-plated, compression type, Burndy type, YA, NEMA 1 hole for sizes No. 6 through No. 1/0 AWG. Burndy type YGHA, NEMA 2 hole pad for sizes No. 2/0 AWG and larger.
- B. Split Bolt Connectors: Burndy SERVIT, type KS
- C. Taps and Splices:
  - 1. Grounding Grid below Grade: Exothermic type (Cadweld) or compression type (Burndy Hyground).
  - 2. Above Grade: Compression type.

#### 2.04 CONDUIT CONNECTORS:

- A. Conduit Clamps: Burndy type GAR or GD.
- B. Grounding Bushings: 0-Z/GEDNEY

#### 2.05 GROUNDING ELECTRODES:

- A. Ground Rods: ¾ inch diameter, 10 feet long, copper clad steel with high strength sheath, molten welded to core.
- B. Rod Connectors:
  - 1. Exothermic type: Cadweld
  - 2. Mechanical type: Burndy type GAR or GD
- C. Test Wells: (Not Required)

#### 2.06 INSULATING MATERIALS:

- A. Tape: Scotch 33+ vinyl plastic.
- B. Mastic Pads: Scotch EZ – Seal

### PART 3 EXECUTION

#### 3.01 INSTALLATION:

- A. General:
  - 1. Provide grounding of systems, equipment and structures in accordance with NEC Article 250, the requirements of the authority having jurisdiction and the design drawings.
- B. Service Entrance:

1. Provide a main bonding jumper between the service neutral conductor, the service equipment ground bus and the service equipment enclosure.
2. Provide a grounding electrode conductor to connect the service neutral conductor to the main grounding electrode.

B. Building Steel and Piping:

1. Provide bonding jumper from the service neutral to the building steel and metallic piping systems.

E. Equipment Grounding:

1. Provide a green insulated equipment grounding conductor in all branch circuits and feeder conduits. Size conductor in accordance with NEC 250 unless otherwise indicated on the drawings.
2. Connect the equipment grounding conductor to panelboard or switchgear ground bus and to all metallic raceways, outlet boxes, lighting fixtures, equipment enclosures, appliances and motor frames.
3. Where metallic raceways are installed, both the raceway and the internal equipment grounding conductor shall be utilized for equipment grounding.

F. Grounding Grid:

1. Excavate and backfill for main grounding grid conductor. Locate conductors at least 3 feet away from foundation. Conductor depth shall be 18 to 24 inches below finished grade.
2. Install ground rods vertically in undisturbed soil so that the top of the rod is 18 to 24 inches below finished grade, except that in test wells the top of rods shall be 6 to 8 inches below grade. Space rods a minimum of 10 feet apart.
3. Make underground cable to cable connections using either exothermic or compression type connections.
4. Provide test wells where indicated on the drawings. Install top of test well flush with finished grade or pavement. Use only bolted type rod connectors in test wells.
5. In addition to equipment grounding conductor connections, make connections from the grounding grid to the following items using green, insulated conductors:
  - a. Electrical equipment ground busses
  - b. Electrical equipment enclosures

- c. Motor frames
  - d. Steel support frames for electrical equipment
  - e. Building steel frame
6. Grounding conductors stubbed up from below grade shall be enclosed in a 1 inch Schedule 40 PVC protective sleeve.

G. Conduit:

- 1. Provide grounding bushings where metallic conduits connect to non-metallic enclosures or stub-up into open-bottom, floor-mounted enclosures.
- 2. Provide conduit grounding clamps where metallic conduit stub-ups are connected to non-metallic underground conduits.

END OF SECTION

## **SECTION T-16075 ELECTRICAL IDENTIFICATION**

### **PART 1 GENERAL**

#### **1.01 SUMMARY:**

**A. Section Includes:**

1. Equipment nameplates and labels
2. Warning and caution signs
3. Operational instruction signs
4. Identification labeling of conduits, cables

**B. Related Sections:**

1. Additional identification requirements are specified in other Sections of Division 16.

#### **1.02 REFERENCES:**

**A. Code of Federal Regulations (CFR)**

1. 29CFR1910.145 Specification for Accident Prevention Signs

**B. National Fire Protection Association (NFPA)**

1. 70 National Electrical Code

#### **1.03 SUBMITTALS FOR APPROVAL:**

**A. Procedure:** Submit in accordance with Section 01300 and 16010.

**B. Product Data:** Submit for each type of product used on project.

**C. Schedules:** Nameplate engraving schedule.

### **PART 2 PRODUCTS**

#### **2.01 ELECTRICAL IDENTIFICATION PRODUCTS:**

**A. Engraved Nameplates and Signs:**

1. Material: 3 ply plastic laminate, matte-finish, 0.125 inch thickness, white with black center core except that material used for warning signs shall be



- red with white center core. Provide punched mounting holes for mechanical fasteners.
2. Size: Minimum size to be 1 inch by 2.5 inches, rectangular shape with square corners.
  3. Engraving: Accurately align lettering and engrave into center core. Lettering shall be normal block style. Character size shall be 3/8 inch high for grouped equipment and load designation and 1/4 inch for individual equipment, loads and devices.

B. Warning Signs:

1. Fiberglass reinforced polyester, non-adhesive backed, indoor-outdoor with punched mounting holes, Brady B-120.
2. Polyester overlaminated with plastic coating, adhesive-backed, indoor-outdoor, Brady B-302.
3. High Voltage warning signs to read "Danger-High Voltage-Keep Out."
4. Provide identical signs for each application.

## PART 3 EXECUTION

### 3.01 INSTALLATION:

A. General:

1. Provide labels and signs in accordance with NEC requirements.
2. Install labels and signs at locations for best convenience of viewing without interference with operation and maintenance of equipment.
3. All nameplates and signs used on the project shall be of similar size, style and appearance.

B. Equipment Nameplates:

1. Provide engraved identification nameplates for each of the following:
  - a. Panelboards
  - b. Circuit breakers
  - c. Switches
  - d. Contactors
  - e. Pull and junction boxes
2. Nameplate legends shall include the equipment identification number as indicated on the design drawings and an appropriate service description.
3. Nameplates for switchgear assemblies, panelboards, and separately enclosed breakers, switches, starters and contactors shall include the operating voltage.

4. Attach engraved nameplates to equipment with self-tapping, stainless steel, round head screws. Use adhesive attachment only where the substrate material is not suitable for screw attachment.

C. Warning Signs:

1. Voltage warning signs where required by the NEC, where indicated on drawing and as follows:
  - a. Equipment Rooms: On all doors to equipment rooms containing equipment or circuits over 600 volts or containing exposed live parts. Minimum size shall be 7 inches x 10 inches.
  - b. Pull Boxes: On removable covers for all pull and junction boxes containing circuits over 600 volts.
  - c. Equipment: On front and rear compartment access doors and covers enclosing live parts. Signs provided as part of equipment that meet these requirements are acceptable.
  - d. Fences: On each gate and on each side of fences that enclose equipment or circuits over 600 volts or exposed live parts. Minimum size shall be 10 inches by 14 inches. Locate at intervals not exceeding 30 feet.

2. Multiple Source Signs:

- a. Where enclosures contain voltages from more than one source which are not interrupted by opening the local unit disconnecting means, provide an engraved nameplate bearing the following (or similar) legend:

“WARNING – MULTIPLE ELECTRICAL SOURCES EXIST  
WITHIN THIS ENCLOSURE”

OR

“WARNING – VOLTAGE MAY BE PRESENT WITH  
DISCONNECT SWITCH OPEN”

3. Hazardous Operation:

- a. Where operation of an electric switch or control device may create an unsafe or undesirable operating condition, provide an engraved plastic sign with appropriate warning statement.

D. Multiple Services:

1. Where multiple services exist, provide each service disconnect with an additional sign which states the name and location of other service disconnects.

E. Conduits:

1. Identify conduits at each termination and at all transitions from exposed to concealed or underground installation.
2. Mark conduits legibly with a permanent marker pen to indicate conduit per circuit number.

F. Cables:

1. Identify cables in pull and junction boxes, vaults, manholes and where entering switchgear panelboard assembly.
2. Provide an engraved plastic nameplate or other suitable permanent tag for each cable or cable assembly. Attach with self-locking nylon cable tie.
3. Cable identification shall include circuit number and phase as indicated on drawings.

END OF SECTION

## **SECTION T-16123 WIRE AND CABLE**

### **PART 1 GENERAL**

#### **1.01 SUMMARY:**

- A. Section includes copper wire, cable, associated connectors, and termination hardware used on systems operating at 600 volts or less.

#### **1.02 REFERENCES:**

- A. American Society for Testing and Materials (ASTM)
  - 1. B8 Concentric-Lay-Stranded Copper Conductor, Hard, Medium Hard, Or Soft.
- B. National Electrical Contractor Association (NECA)
  - 1. Standard of Installation
- C. National Fire Protection Association (NFPA)
  - 1. 70 National Electrical Code
- D. Underwriters Laboratories Inc. (UL)
  - 1. 44 Rubber-Insulated Wires and Cables
  - 2. 83 Thermoplastic-Insulated Wires and Cables
  - 3. 486A Wire Connectors and Soldering Lugs for Use With Copper Conductors
  - 4. 486C Splicing Wire Connectors
  - 5. 510 Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
  - 6. 1569 Metal-Clad Cables

#### **1.03 SUBMITTALS – FOR APPROVAL:**

- A. Procedures: Submit in accordance with Section 01300 and 16010.
- B. Product Data: Submit for each type of wire and cable, terminal lugs, connectors, and cable fittings.

#### **1.04 SUBMITTALS – RECORD DATA:**

- A. Procedure: Submit in accordance with Section 01300.
- B. Product Data: Approved, as furnished data as listed above.

#### 1.05 QUALITY ASSURANCE:

- A. Furnish wire, cable, associated connectors, and termination hardware bearing UL label.

### PART 2 PRODUCTS

#### 2.01 BUILDING WIRE:

- A. Single conductor, soft drawn, annealed copper conductor, Class B stranded except that sizes No. 10 AWG and smaller used for lighting and power branch circuits may be solid. Insulation shall be 600 volt, type THHN/THWN per UL 83 or type XHHW per UL 44.

#### 2.02 TYPE MC CABLE: Metal Clad Cable type MC multi-conductor cabling as manufactured by AFC Cable Systems or equivalent having the following construction features:

- A. Conductor: Bare, soft annealed copper, Class B stranded per ASTM B-8.
- B. Insulation: Polypropylene tape assembly with 600 volt, 90°C (dry) type THHN insulation with printed number and color identification.
- C. Neutral conductor: White – 120v circuits; Gray – 480Y277v circuits
- D. Grounding conductor: Green insulated copper ground conductor.
- E. Assembly: Three insulated conductors with grounding conductor, non-hygroscopic fillers and overall binder tape per UL 1569.
- F. Sheath: High strength, lightweight galvanized interlocking steel strip and color coded on the out side for easy identification.
- G. U.L rated 1569

#### 2.03 CONNECTORS AND TERMINALS:

- A. Insulated Crimp Type Connectors and Terminals: Nylon insulated, Burndy INSULINK and INSULUG, or Thomas & Betts Sta-Kon.
- B. Split Bolts: High-conductivity copper alloy, Burndy SERVIT or Thomas & Betts Split-Bolt.
- C. Two Bolt Connectors: High-conductivity copper alloy, Burndy OKLIP, Type KVS or Blackburn 2BU.
- D. Compression Terminals: Copper, long barrel, Burndy HYLUG or Thomas & Betts Color-Keyed.

- E. Bolted Terminals: Cast copper alloy, Burndy QIKLUG or Thomas & Betts Locktite.
- F. Spring Wire Connectors: Insulated, twist-on type, Ideal Wire Nut or 3M Scotchlok

#### 2.04 CABLE TERMINATIONS:

- A. Type MC Cable: Steel set screw connectors

#### 2.05 MISCELLANEOUS COMPONENTS:

- A. Tape: UL 510
  - 1. Vinyl Plastic: 3M Scotch 33+ or Scotch 88.
  - 2. Varnished Cambric (VC): 3M Irvington 2920.
  - 3. Friction: Black friction tape.
- B. Pulling Lubricants: Ideal Yellow 77 or Polywater Type J.
- C. Wire Markers:
  - 1. Individual Wires: Heat shrink, machine printed, Raychem.
  - 2. Multi-Conductor Cables or Groups of Wires as a Cable: Nylon tie on marker, Thomas & Betts Nylon I.D. Ties, Ty-Raps.
- D. Wire and Cable Ties: Thomas & Betts Ty-Raps.

### PART 3 EXECUTION

#### 3.01 APPLICATION:

- A. Wire and Cable:
  - 1. THWN-THHN for power wiring through No. 250 AWG and control wiring in conduit. XHHW for sizes above No. 250 AWG in conduit.
  - 2. TW or THW for equipment grounding conductor.
  - 3. Type MC cable for fixture wires no longer than 6' and in accordance with NEC Article 334.
  - 4. No. 12 AWG minimum for power circuits and No. 14 AWG minimum for control circuits unless noted otherwise on drawings.
- B. Splices and Taps:
  - 1. Use insulated spring wire connectors for lighting and receptacle branch circuits No. 10 AWG and smaller.
  - 2. Use solderless pressure connectors for branch circuit conductors No. 8 AWG and larger.
  - 3. Do not make splices or taps in feeder circuits or control circuits.

C. Terminals:

1. Use copper compression terminals, NEMA 1 hole for sizes No. 4 AWG and smaller, NEMA 2 hole for sizes No. 2 AWG and larger.
2. Use insulated, ring tongue terminals for signal and control conductors.

3.02 INSTALLATION:

A. Install wire and cable in accordance with the NECA Standard of Installation.

B. Installation in Conduit:

1. Swab conduits completely and thoroughly before pulling in conductors.
2. Pull all conductors into conduit at same time.
3. Use suitable wire pulling lubricant for building wire No. 4 AWG and larger.
4. Do not pull in conductors until conduit system is completed. Do not pull through boxes, fittings or enclosures where a change of conduit alignment or direction occurs.
5. Limit pulling tension to maximum values as recommended by manufacturer.
6. Do not combine circuits into a common conduit other than as indicated on the drawings.

C. Direct Burial Cable:

1. Trench and backfill for direct burial cables. Minimum depth of installation shall be 24 inches.
2. Terminate and ground metallic cable sheath with suitable fittings.

D. Compression Connectors and Terminals:

1. Install on wire and cable with approved tool and die to recommended compression pressure. Do not cut strands from conductors to fit lugs or terminals.

E. Bolted Connectors and Terminals:

1. Torque to manufacturer's recommended foot-pounds for size and class of connector.
2. Where manufacturer's published torquing requirements are not indicated, tighten connectors and terminals to comply with UL 486A torque values.
3. Use galvanized steel bolts, nuts, split-lock washers and flat washers on terminal connections.

F. Wiring in Enclosures:

1. Form and tie conductors in panelboards, cabinets, control panels, motor controllers, wireways, and wiring troughs in a neat and orderly manner.
2. Use Thomas & Betts wire and cable ties of appropriate size and type.
3. Limit spacing between ties to not more than 6 inches.

G. Taping:

1. Above Ground and Dry Locations: Fill voids and irregularities with half-lapped layers of VC (two minimum) or electrical insulation putty. Insulate with three half-lapped layers of vinyl plastic and one half-layer of friction tape.
2. In damp or wet locations, wrap insulated spring wire connectors with 2 layers of vinyl plastic tape.

### 3.03 COLOR CODING:

- A. Power Wiring: Provide color coding for single and multi-conductor power circuits as follows:

<u>Voltage</u>	<u>ΦA</u>	<u>ΦB</u>	<u>ΦC</u>	<u>Neutral</u>
240 volts and below	Black	Red	Blue	White
250 – 600 volts	Brown	Purple	Yellow	Gray

1. For specified insulation and jackets not manufactured with integral colors, use conductors with black insulation or jacket and color-coding tape.
2. Color code conductors entering boxes, troughs, cabinets, and other enclosures.
3. Color code conductors in wireways, trenches, and other locations where conductors are continuously accessible at intervals not exceeding 5 feet.

- B. Insulated Equipment Ground: Green.

- C. Isolated Ground conductor: Green with Yellow tracer.

### 3.04 WIRING IDENTIFICATION

- A. Control Circuits: Install a permanent wire label at each termination. Identifying numbers shall match approved schematic and wiring diagrams.
- B. Feeder and Branch Circuits: Install a permanent wire label at each termination. Identifying numbers shall include source panel designation and circuit number.

### 3.05 FIELD TESTS:

- A. Test conductors after installation is complete and prior to connection to equipment.



- B. Perform insulation resistance test on each conductor phase-to-ground with adjacent conductors grounded and test conductor disconnected from equipment. Applied potential shall be 1000 volts dc for one minute. Minimum acceptable test values shall be 50 megohms. Investigate deviations in test values between adjacent phases.
- C. Verify tightness of bolted connections with a calibrated torque wrench. Torque values shall be terminal lug manufacturer's recommendations.

END OF SECTION

## **SECTION T-16136 RACEWAYS**

### **PART 1 GENERAL**

#### **1.01 SUMMARY:**

##### **A. Section Includes:**

1. Rigid Galvanized Steel Conduit (RGS)
2. PVC-Coated Rigid Steel Conduit (CRGS)
3. Rigid Aluminum Conduit (RAC)
4. Electrical Metallic Tubing (EMT)
5. PVC Conduit (PVC)
6. Flexible Conduit
7. Associated Fittings
8. Wireways
9. Pull and Junction Boxes

#### **1.02 REFERENCES:**

##### **A. American National Standards Institute (ANSI):**

1. C80.1 Rigid Steel Conduit – Zinc Coated
2. C80.3 Electrical Metallic Tubing – Zinc Coated
3. C80.5 Rigid Aluminum Conduit

##### **B. National Electrical Manufacturers Association (NEMA):**

1. TC 2 Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
2. TC 3 PVC Fitting for Use with Rigid PVC Conduit and Tubing
3. TC 13 Electrical Nonmetallic Tubing (ENT)
4. TC 14 Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings.

##### **C. National Fire Protection Association (NFPA):**

1. 70 National Electrical Code

##### **D. Underwriters Laboratories Inc. (UL):**

1. 1 Flexible Metal Conduit
2. 5 Surface Metal Raceways and Fittings
3. 5A Nonmetallic Surface Raceways and Fittings
4. 6 Rigid Metal Conduit
5. 360 Liquid-Tight Flexible Steel Conduit
6. 514B Fittings for Conduit and Outlet Boxes
7. 797 Electrical Metallic Tubing
8. 870 Wireways, Auxiliary Gutters, and Associated Fittings
9. 886 Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations

1.03 SUBMITTALS – FOR APPROVAL:

- A. Procedure: Submit in accordance with Section 01300 and 16010.
- B. Product Data: Submit for each type of conduit, fitting, connector, pull and junction box, and wireway used on the project.

1.04 SUBMITTALS – RECORD DATA:

- A. Procedure: Submit in accordance with Section 01300.
- B. Product Data: Approved, as furnished data as listed above.

PART 2 PRODUCTS

2.01 RIGID GALVANIZED STEEL (RGS):

- A. Conduit: Conduit including elbows, couplings, and nipples shall be standard weight zinc-coated steel, rigid threaded conduit; shall meet the requirements of ANSI C80.1; and shall be hot-dipped galvanized inside, outside and over threads and lacquered inside.
- B. Fittings: Conduit fittings and accessories for use with RGS conduit shall be cast malleable iron or ferrous alloy, hot-dipped galvanized or zinc-electro-plated and lacquered. Fittings shall have threaded hubs and gasketed covers. Fittings shall be the product of Crouse-Hinds, Appleton or Gedney or an equal.
- C. Boxes: Device and outlet boxes for use with RGS conduit shall be cast malleable iron, hot-dipped galvanized or zinc-electro-plated and lacquered. Boxes shall have threaded hubs and gasketed covers. Boxes shall be the product of Crouse-Hinds, Appleton, Gedney or equal.
- D. Fasteners and Supports: All clamps, straps, framing and supporting materials shall be hot-dipped galvanized steel or malleable iron. Bolts, nuts, screws, washers, etc. shall be stainless steel. Cadmium-plated or zinc-plated fasteners and hardware will not be acceptable.

2.02 POLYVINYL CHLORIDE (PVC - SCHEDULE 40):

- A. Conduit: Conduit, elbows and couplings shall be Schedule 40 rigid polyvinyl chloride (PVC) conduit per NEMA TC 2 with a 90<sup>0</sup> UL rating, and shall be the standard product of Krayloy or Carlon or approved equal.
- B. Fittings: Fittings and accessories for use with Schedule 40 PVC conduit shall conform to NEMA TC 3 and shall be of the same material and manufacturer as the conduit.

2.03 PVC COATED STEEL CONDUIT (CRGS):

- A. Conduit: Prior to coating, all conduits, elbows, couplings, nipples etc. shall be standard weight rigid, threaded steel and shall be hot dipped galvanized inside

and out and over the ends. The conduit shall meet the requirements of ANSI C80.1, UL 6, and NEMA RN-1, 1980.

- B. Fittings: Prior to coating, fittings shall be cast malleable iron, hot dipped galvanized, Appleton Form 35 or Crouse-Hinds or equivalent with cast cover and neoprene gasket.
- C. Boxes: Device and outlet boxes for use with PVC coated conduit shall be cast malleable iron, hot dipped galvanized with threaded hubs and gasketed cast covers or device plates. Boxes shall be the product of Appleton or Crouse-Hinds.
- D. PVC Coating: Conduit, fittings, boxes and accessories shall be Plasti-Bond 2 coated, as produced by Robroy Industries Inc. or an approved equal. Before coating, the galvanized surfaces shall be coated with an epoxy-acrylic primer. Exterior surfaces shall have a 40 mil PVC coating applied by dip method. Interior surfaces of conduits, fittings, boxes, etc. shall have a fusion bonded phenolic coating with a thickness of 4-6 mils.
- E. Fasteners and Supports: U-bolts, conduit clamps, straps, modular framing channels shall be 1-5/8" x 1-5/8" minimum section dimensions, Type 304 stainless steel, and shall be the product of Unistrut. Fasteners and attachment hardware shall be Type 304 stainless steel.

#### 2.04 RIGID ALUMINUM CONDUIT:

- A. Conduit: Conduit, including elbows, couplings and nipples shall be standard weight, threaded, rigid aluminum 6063 alloy, with a copper content not to exceed 0.20%. The conduit shall have a silicon or lacquer coating inside.
- B. Fittings: Fittings, accessories and device boxes for aluminum conduit systems shall be the standard threaded type as manufactured by Crouse-Hinds, Appleton, or equal. Both fittings and covers shall be aluminum containing less than 0.4 of 1% copper. All screws shall be stainless steel. Covers shall be gasketed.
- C. Fasteners: All straps and clamps used to support aluminum conduit shall be hot-dipped galvanized steel or malleable iron, with a 40 mil fused PVC coating, Plastibond, Ocal or equivalent. Strut type framing channels shall be either PVC coated galvanized steel or fiberglass.
- D. Hardware: Nuts, bolts, screws, washers, etc. shall be stainless steel. Galvanized or cadmium-plated hardware will not be acceptable for use with aluminum conduit.

#### 2.05 ELECTRICAL METALLIC TUBING (EMT):

- A. Conduit: Conduit, including elbows, couplings, and nipples shall be hot dipped galvanized steel inside and out with an organic corrosion resistant coating applied to the inside.
- B. Fittings and Boxes: Conduit fittings, boxes, and accessories for use with EMT conduit shall be cast malleable iron or ferrous alloy, hot-dipped galvanized or zinc-electro-plated and lacquered. Fittings shall be compression type. Setscrew

fittings are not acceptable. Fittings shall be the product of Crouse-Hinds, Appleton, OZ Gedney or an equal.

- C. Fasteners and Supports: All clamps, straps, framing and supporting materials shall be hot-dipped galvanized steel or malleable iron.

## 2.06 LIQUID-TIGHT FLEXIBLE METAL CONDUIT:

- A. Flexible Conduit: Flexible conduit shall have a spiraled, flexible, galvanized steel inner core and an outer jacket of neoprene. Sizes 3/8" through 4" shall have a continuous, internal copper ground. Liquid-tight connectors shall be galvanized steel or malleable iron with neoprene sealing gaskets, external ground lugs and insulated throats. Connectors shall be Appleton type STB or Gedney or equal.

## 2.07 WIREWAYS:

- A. Sheet Metal:
  - 1. Indoor, dry locations: NEMA 1, sheet steel per UL 870 with hinged cover per NEMA ICS 6. Finish being manufacturer's standard gray enamel.
  - 2. Outdoor and damp locations: NEMA 3R, galvanized sheet steel per UL 870 with hinged cover per NEMA ICS 6.
- B. Non-Metallic:
  - 1. NEMA 4X, Robroy Industries fiberglass trough with gasketed cover attached with non-metallic fasteners.
- C. Fittings and Accessories: Include couplings, hubs, elbows, adapters, end caps and other fittings to match and mate with type of wireway furnished as required for a complete system.

## PART 3 EXECUTION

### 3.01 APPLICATION:

- A. General:
  - 1. All field wiring shall be installed in conduit except as otherwise indicated.
  - 2. Minimum conduit size shall be 1/2-inch nominal diameter.
- B. Exposed:
  - 1. Conduit installed outdoors exposed shall be rigid galvanized steel.
  - 2. Conduit installed indoors exposed and below 7 feet shall be rigid galvanized steel. Exposed conduit above 7 feet installed indoors may be EMT.
- C. Underground:
  - 1. Conduit installed underground shall be Schedule 40 PVC. See section 3.02-E for additional requirements.
  - 2. Elbows used for underground conduit stub-ups from below grade shall be PVC coated rigid galvanized steel, non-metallic Schedule 80 PVC, or

Rigid Galvanized Steel completely taped with non-corrosive protective tape.

D. Concealed:

1. Conduit installed concealed above lay-in ceilings and in dry wall construction shall be EMT.

E. Flexible Connections:

1. Indoor-dry areas: Flexible metal conduit.
2. Indoor-wet, damp areas: Liquid-tight, flexible metal conduit.
3. Outdoors: Liquid-tight, flexible metal conduit.

3.02 INSTALLATION:

A. General:

1. Installation Methods: Conduit shall be installed concealed in walls or above ceiling or underground as indicated on the drawings.
2. Cleaning: All conduit systems shall be completed and shall be swabbed clean before conductors are pulled in.
3. Field cuts: Do not cut conduit with pipe cutters.
4. Bends: Field made bends and offsets shall be made with a hickey or conduit bending machine. Crushed or deformed raceways shall not be installed. The maximum number of 90° bends, or equivalent between pulling points in any conduit run shall be three. Pull and junction fittings and/or boxes shall be provided as necessary to satisfy this requirement.
5. Protection: The ends of all conduit runs shall be closed immediately after installation to prevent the accumulation of water, dirt and other foreign material.
6. Locknuts: Conduits shall be fastened to all sheet metal boxes and cabinets with two locknuts. Locknuts shall have sharp edges for digging into the wall of metal enclosures. Bushings shall be installed on the ends of all conduits and shall be the insulating type.
7. Conduit couplings shall be threaded type for RGS or RA conduit and compression type for EMT conduit. Set-screw couplings are not acceptable.
8. Spare conduits: Spare conduits shall have a pull cord installed. The pull cord shall be plastic with a minimum tensile strength of 200 pounds. Not less than 12 inches of slack shall be left at each end of the pull cord.
9. Supports: Supports shall be provided a minimum of every 10' and within 3' of all enclosures. In addition, conduits shall be rigidly supported between couplings, on either side of bends and at terminations and fittings.

10. Boxes: Boxes shall be provided in the raceway system as indicated on the drawings and also wherever required for pulling of wires or making connections. Unless otherwise shown on the drawings, boxes installed in normally wet locations or on the outside of exterior surfaces shall be NEMA 3R, stainless steel sheet construction. Boxes shall be furnished with hinged and gasketed doors and stainless steel back panels. Each box shall have the volume required by the NEC for the number of conductors enclosed in the box. All boxes shall be securely anchored in place.
11. Flexible Connections: Flexible connections of short length shall be provided for equipment subject to vibration, noise transmission or movement. A separate ground conductor shall be provided across all flexible connections. Flexible conduit connections shall be rigidly and securely supported in an approved manner at intervals not exceeding 24 inches in length and within 12 inches of each conduit termination. Lengths of not more than 36 inches may be installed without such supports where flexibility is required.
12. Identification: Identify conduits in accordance with Section 16075.
13. PVC: PVC conduit joints shall be solvent cement welded and shall be watertight. All PVC conduits shall have a separate grounding conductor installed. Where transition is made to the metallic conduit or enclosures, the grounding conductor shall be bonded to the metal conduit or enclosure.
14. Penetrations through walls, floors, and roof: All penetrations shall be sealed with a UL listed fire sealant equal to Dow Corning #3-6548.

B. Exposed Conduit:

1. Routing: Exposed conduit shall be run straight and true to structure lines. Changes in direction of runs shall be made with fittings or symmetrical bends. Conduit in damp locations or outdoors shall be exposed to the air on all sides and shall not be installed tight against walls, ceilings and structural members, etc. Clamp backs and/or offsets shall be used as necessary to maintain uniform clearances.
2. Supports: Acceptable supporting and clamping materials for exposed conduit include one-hole straps and clampback, "U" bolts, parallel or right angle conduit clamps, hot-dipped galvanized structural steel frames or modular stainless steel channel as manufactured by Unistrut or equal. Perforated steel tape, stamped steel one- and two-hole straps shall not be used. Conduits shall be supported in accordance with NEC 346-12.
3. Obstructions: Conduit shall be routed so as not to create any tripping or head banging hazard and so as not to create any obstruction to Owner's operation and maintenance activities.
4. Hubs: Watertight conduit hubs shall be installed where conduits enter the tops or sides of sheet metal or non-metallic enclosures.

5. Drains: Drain fittings shall be installed at low points throughout the conduit system where condensation is likely to occur.

C. PVC Coated Conduit:

1. PVC coated conduit requires special care to minimize damage to the PVC coating during cutting, threading, bending and installation. Contractor shall install conduit in accordance with manufacturer's recommended installation procedures.
2. Contractor shall be responsible for providing strap wrenches, cutting dies, vises, and other special tools required to install PVC coated conduit. Standard pipe wrenches, chain wrenches or channel locks shall not be used. Conduit bending equipment shall have the proper diameter shoes or dies to allow for the thickness of the PVC coating.
3. PVC coated conduit shall be supported with Type 304 stainless steel clamps, straps, hangers and supports. Attachment hardware shall be Type 316 stainless steel.
4. All PVC coated conduit and fittings that have teeth marks, cuts, nicks or are otherwise damaged shall be repaired by coating damaged area with a liquid PVC touch-up compound. Spray-type compound is not acceptable.
5. Unistrut channel supports and related accessories for use with PVC coated conduit shall be Type 304 stainless steel.

D. Aluminum:

1. Aluminum conduit shall not be installed in direct contact with earth, concrete, steel, copper, brass or bronze. Where aluminum conduit comes into contact with dissimilar metals or passes through concrete walls or floors, it shall be wrapped with 2 layers, half-lapped, of corrosion preventative pipe tape, Scotch 50 or equal.
2. Aluminum conduit threads shall have a Penetrox, No-Ox-Id or equal, applied when installed.

E. Underground Conduit:

1. Under Landscaping (i.e. sod or grass):
  - a. Underground conduit runs shall be laid in sand and covered with a 4" red concrete cap. The conduit shall be surrounded by a minimum of 3-inches of virgin sand (top, bottom, and sides).
  - b. Where conduits are routed under paved areas that are accessible to vehicles, the conduit shall be encased in steel reinforced concrete duct bank. See Section 16136-3.02-E-2.
  - c. The top of concrete cap or duct bank shall be a minimum of 24 inches below grade, unless otherwise indicated and must go below conflicts, such as yard piping, if the 24 inches minimum depth cannot be met. Compact trench backfill to original density.



2. Concrete Encasement (Under Driveways and Roads):
  - a. Underground conduit runs shall be encased in red concrete. The minimum thickness of cover shall be 3 inches.
  - b. Where conduits rise above grade, the concrete encasement shall extend to 6 inches above grade. Exposed concrete shall be natural color, not red. Where conduits run through equipment foundations or floor slabs, the concrete encasement shall butt the underside of the slab.
  - c. The top of concrete encasement shall be a minimum of 24 inches below grade, unless otherwise indicated and must go below conflicts, such as yard piping, if the 24 inches minimum depth cannot be met. Compact trench backfill to original density.
  - d. The concrete encasement shall be reinforced with a minimum of four (4) No. 4 steel reinforcing bars.
3. Separation: Minimum separation between the outside edges of adjacent conduits shall be 3 inches.
4. Elbows: All elbows shall be long radius type.
5. Spacers: Conduit spacers shall be installed at 5 feet on centers.
6. Expansion Fittings: Provide expansion fittings in aboveground, vertical portion of each underground conduit stub-up.

END OF SECTION

## **SECTION T-16140 WIRING DEVICES**

### **PART 1 GENERAL**

#### **1.01 SUMMARY:**

##### **A. Section Includes:**

1. Receptacles
2. Ground Fault Circuit Interrupter Receptacles
3. Snap Switches
4. Wall Plates

#### **1.02 REFERENCES:**

##### **A. National Electrical Manufacturers Association (NEMA):**

1. WD1-83 General Requirements for Wiring Devices

##### **B. National Fire Protection Association (NFPA):**

1. 70 National Electrical Code

##### **C. Underwriters Laboratories Inc. (UL):**

1. 20-86 Standard for Safety General Use Snap Switches
2. 94-91 Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
3. 498091 Standard for Safety Attachment Plugs and Receptacles

#### **1.03 SUBMITTALS:**

- A. Procedures: Submit for approval and record purposes in accordance with Section 01300 and 16010.
- B. Product Data: Submit for each type of device used on project.

#### **1.04 QUALITY ASSURANCE:**

##### **A. Items provided under this section shall be listed and labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).**

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be defined as they are in National Electrical Code, Article 100.

##### **B. Regulatory Requirements:**

1. National Electrical Code: Components and installation shall comply with NFPA 70.

## PART 2 PRODUCTS

### 2.01 WIRING DEVICES:

- A. General: Provide wiring devices, in types, characteristics, grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA Standards.
- B: Receptacles, General Use Duplex Receptacles: 125 volt, 15 or 20 amp, heavy duty, grounding type:

<u>Manufacturer</u>	<u>Color</u>	<u>5-15R Duplex</u>	<u>5-20-R Duplex</u>
Hubbell	Ivory	5262-I	5362-I
Leviton	Ivory	5262-I	5362-I
P & S	Ivory	5262-I	5362-I

- C: Ground-Fault Circuit Interrupter (GFCI) Receptacles: 125 volt, 15 or 20 amp, heavy duty, grounding type "non feed-through" conforming to UL 498 and UL 943:

<u>Manufacturer</u>	<u>Color</u>	<u>5 - 15R</u>	<u>5 - 20R</u>
Hubbell	Ivory	GF5262-I	GF5362-IA
Leviton	Ivory	7599-I	7899-I
P & S	Ivory	1591-RI	2091-IL

- D: Snap Switches: 120/277 volt, 20 ampere, quiet rated, heavy duty, complying with UL 20 and NEMA WD1:

<u>Manufacturer</u>	<u>Color</u>	<u>1 Pole</u>	<u>2 Pole</u>	<u>3 Way</u>	<u>4 Way</u>
Hubbell	Ivory	1221-I	1222-I	1223-I	1224-I
Leviton	Ivory	1221-2I	1222-2I	1223-2I	1224-2I
P & S	Ivory	20AC1-I	20AC2-I	20AC3-I	20AC4-I

### 2.02 WIRING DEVICE ACCESSORIES:

- A. Wall Plates:
1. Single and combination, of types, sizes, and with ganging and cutouts as required by devices.
  2. Provide plates which mate and match with wiring devices to which attached.
  3. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates.
  4. Provide plates possessing following additional construction features.
    - a. Device plates: stainless steel.
    - b. Device plates for surface mounted, 4 inch sq boxes: 1/2 inch stainless steel covers.
    - c. Weatherproof covers for exterior devices or devices in damp locations: Raintight while in use, UL listed, molded UV stabilized poly-carbonate with stainless steel screws and mounting gaskets. Tay Mac Corporation safety outlet enclosure, or equal.

## PART 3 EXECUTION

### 3.01 INSTALLATION:

- A. Install wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other Work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other Work.
- C. Install wiring devices only in electrical boxes that are clean; free from building materials, dirt and debris.
- D. Mounting Heights: Unless otherwise indicated or directed, boxes for wiring devices shall be mounted so that the centerline of the device is at the following height above finished floor (AFF) or above finished grade (AFG).

<u>DEVICE</u>	<u>FINISHED AREAS</u>	<u>UNFINISHED AREAS</u>
Snap switches	48"	48"
Convenience Receptacles	18"	18"

- E. Install wiring devices after wiring work is completed.
- F. Install wall plates after painting work is completed.
- G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A. Use properly scaled torque indicating hand tool.
- H. Do not use terminals on wiring devices (hot or neutral) for feed-through connections, looped or otherwise. Make circuit connections via wire connectors and pigtails.
- I. Ground receptacles with insulated green ground wire from device ground screw to bolted outlet box connection.

### 3.02 PROTECTION:

- A. Protect installed components from damage. Replace damaged items prior to final acceptance.

### 3.03 FIELD QUALITY CONTROL:

- A. Testing: Prior to energizing circuits, test wiring for electrical continuity and for short circuits. Ensure proper polarity of connections is maintained. Subsequent

to energizing, test wiring devices and demonstrate compliance with requirements, operating each operable device at least six (6) times.

- B. Test receptacles with Hubbell 5200, Woodhead 1750 or equal for correct polarity, proper ground connection and wiring faults.
- C. Test ground fault interrupter operation with both local and remote fault simulations in accordance with manufacturer's recommendations.

END OF SECTION

**SECTION 16235**  
**EMERGENCY/STANDBY POWER SYSTEMS**  
**GENERATOR SET(S)**

**PART 1. GENERAL**

**1.01 SCOPE**

- A. Provide complete factory assembled generator set equipment with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator.
- B. Provide factory test, startup by a supplier authorized by the equipment manufacturer(s), and on-site testing of the system.
- C. The generator set manufacturer shall warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

**1.02 CODES AND STANDARDS**

- A. The generator set installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable. The generator set shall include necessary features to meet the requirements of these standards.
  - 1. CSA 282, 1989 Emergency Electrical Power Supply for Buildings
  - 2. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
  - 3. NFPA37 –
  - 4. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
  - 5. NFPA99 – Essential Electrical Systems for Health Care Facilities
  - 6. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.
- B. The generator set and supplied accessories shall meet the requirements of the following standards:
  - 1. NEMA MG1-1998 part 32. Alternator shall comply with the requirements of this standard.
  - 2. UL142 – Sub-base Tanks
  - 3. UL1236 – Battery Chargers
  - 4. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed..
- C. The control system for the generator set shall comply with the following requirements.

1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
  2. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
  3. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
  4. FCC Part 15, Subpart B.
  5. IEC8528 part 4. Control Systems for Generator Sets
  6. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
  7. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
  8. UL1236 –Battery Chargers.
- D. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

#### 1.03 ACCEPTABLE MANUFACTURERS

- A. Only approved bidders shall supply equipment provided under this contract. Equipment specifications for this project are based on generator sets manufactured by Cummins Power Generation with microprocessor-based controls.
- B. Acceptable manufacturers include:
1. Kolher
  2. Generac
  3. Caterpillar
  4. Taylor Power Systems
- C. Requests for substitutions must be submitted 10 days prior to the bid date for consideration. See section 16010-1.10 for substitution submittal requirements. Proposals must include a line by line compliance statement based on this specification.

#### 1.04 SUBMITTALS

- A. Procedure: Submit in accordance with Section 01300, 16010, and as stated herein.
- B. Within 10 days after award of contract, provide six sets of the following information for review:
- Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
  - A paragraph by paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
  - Manufacturer's certification of prototype testing.

- Manufacturer's published warranty documents.
- Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
- Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
- Manufacturer's installation instructions.

## PART 2. PRODUCTS

### 2.01 GENERATOR SET

#### A. Ratings

1. The generator set shall operate at 1800 rpm and at a voltage of: 120/208 Volts AC, Three phase, 4 wire, 60 hertz.
2. The generator set shall be rated at 35 kW, 43.75 kVA at 0.8 PF, Standby rating, based on site conditions of : Altitude 1000ft. , ambient temperatures up to 104 degrees F (40 degrees C).
3. The generator set rating shall be based on emergency/standby service.

#### B. Performance

1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5%.
3. The diesel engine-generator set shall accept a single step load of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
4. Motor starting capability shall be a minimum of 131 kVA. The generator set shall be capable of recovering to a minimum of 90% of rated no load voltage following the application of the specified kVA load at near zero power factor applied to the generator set. Maximum voltage dip on application of this load, considering both alternator performance and engine speed changes shall not exceed 25%.
5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no 3<sup>rd</sup> order harmonics or their multiples. Telephone influence factor shall be less than 40.
6. The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning.

#### C. Construction

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.



2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. All active control components shall be installed within a UL/NEMA 3R enclosure. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

D. Connections

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
3. Generator set control interfaces to other system components shall be made on a permanently labeled terminal block assembly. Labels describing connection point functions shall be provided.

## 2.02 ENGINE AND ENGINE EQUIPMENT

The engine shall be diesel, 4 cycle, radiator and fan cooled. Minimum displacement shall be 239.0 cubic inches, with 4 - cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable.

Engine accessories and features shall include:

- A. An electronic governor system shall provide automatic isochronous frequency regulation. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed. The governing system shall include a programmable warm up at idle and cool down at idle function. While operating in idle state, the control system shall disable the alternator excitation system.
- B. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the alternator air inlet. Radiator fan shall be suitable for use in a system with 0.5 in H<sub>2</sub>O restriction. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture prior to shipping. Rotating parts shall be guarded against accidental contact.
- C. Electric starter(s) capable of three complete cranking cycles without overheating.
- D. Positive displacement, mechanical, full pressure, lubrication oil pump.
- E. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
- F. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
- G. Replaceable dry element air cleaner with restriction indicator.
- H. Flexible supply and return fuel lines.

- I. Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.
- J. Coolant heater
  - 1. Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.
  - 2. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall provisions to isolate the heater for replacement of the heater element without draining the coolant from the generator set. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
  - 3. The coolant heater shall be provided with a DC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
  - 4. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104F (40C) in a 40F (4C) ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.
- K. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.
- L. Starting and Control Batteries shall be calcium/lead antimony type, 12 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three complete 15-second cranking cycles at 40F ambient temperature when fully charged.
- M. Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.
- N. Provide a dual wall sub-base fuel storage tank with a minimum of 75 gallons capacity. The tank shall be constructed of corrosion resistant steel and shall be UL listed. The equipment, as installed, shall meet all local and regional requirements for above ground tanks.

## 2.03 AC GENERATOR

- A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system and shall be UL1446 listed. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees Centigrade.
- B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

- C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.
- D. The subtransient reactance of the alternator shall not exceed 15 percent, based on the standby rating of the generator set.

## 2.04 GENERATOR SET CONTROLS.

The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.

The control shall be mounted on the generator set, or may be mounted in a free-standing panel next to the generator set if adequate space and accessibility is available. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

The generator set mounted control shall include the following features and functions:

### A. Control Switches

- 1. Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or MANUAL position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
- 2. EMERGENCY STOP switch. Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
- 3. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
- 4. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

### B. Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:

- 1. Digital metering set, 1% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three-phase voltages (line to neutral or line to line) simultaneously.
- 2. Analog voltmeter, ammeter, frequency meter, power factor meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Meter scales shall be color coded in the following fashion: green shall indicate normal operating condition, amber shall indicate operation in ranges that indicate potential failure, and red shall indicate failure impending.

Metering accuracy shall be within 1% at rated output. Both analog and digital metering are required.

3. The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments. The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.
4. The control system shall log total number of operating hours, total kWh, and total control on hours, as well as total values since reset.

C. Generator Set Alarm and Status Display.

1. The generator set control shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. Functions indicated by the lamps shall include:
  - The control shall include five configurable alarm-indicating lamps. The lamps shall be field adjustable for any status, warning, or shutdown function monitored by the genset. They shall also be configurable for color, and control action (status, warning, or shutdown).
  - The control shall include green lamps to indicate that the generator set is running at rated frequency and voltage, and that a remote start signal has been received at the generator set. The running signal shall be based on actual sensed voltage and frequency on the output terminals of the generator set.
  - The control shall include a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.
  - The control shall include an amber common warning indication lamp.
2. The generator set control shall indicate the existence of the warning and shutdown conditions on the control panel. All conditions indicated below for warning shall be field-configurable for shutdown. Conditions required to be annunciated shall include:
  - low oil pressure (warning)
  - low oil pressure (shutdown)
  - oil pressure sender failure (warning)
  - low coolant temperature (warning)
  - high coolant temperature (warning)
  - high coolant temperature (shutdown)
  - high oil temperature (warning)
  - engine temperature sender failure (warning)
  - low coolant level (warning)
  - fail to crank (shutdown)
  - fail to start/overcrank (shutdown)
  - overspeed (shutdown)
  - low DC voltage (warning)
  - high DC voltage (warning)
  - weak battery (warning)
  - low fuel-daytank (warning)
  - high AC voltage (shutdown)
  - low AC voltage (shutdown)
  - under frequency (shutdown)
  - over current (warning)

- over current (shutdown)
- short circuit (shutdown)
- over load (warning)
- emergency stop (shutdown)
- (4) configurable conditions

3. Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

D. Engine Status Monitoring.

1. The following information shall be available from a digital status panel on the generator set control :

- engine oil pressure (psi or kPA)
- engine coolant temperature (degrees F or C)
- engine oil temperature (degrees F or C)
- engine speed (rpm)
- number of hours of operation (hours)
- number of start attempts
- battery voltage (DC volts)

2. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

E. Engine Control Functions.

1. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
2. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
3. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
4. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
5. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

F. Alternator Control Functions:

1. The generator set shall include a full wave rectified automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase line to neutral RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate, and be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.
2. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.
3. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.
4. Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
5. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

G. Other Control Functions

1. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and DC voltage shall be monitored as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

H. Control Interfaces for Remote Monitoring:

1. The control system shall provide four programmable output relays. These relay outputs shall be configurable for any alarm, shutdown, or status condition monitored by the control. The relays shall be configured to indicate: (1) generator set operating at rated voltage and frequency, (2) common warning, (3) common shutdown, (4) load shed command.
2. A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
3. A fused 10 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.
4. The control shall be provided with a direct serial communication link for the LonWorks communication network interface as described elsewhere in this specification and shown on the drawings.

2.05 OTHER EQUIPMENT TO BE PROVIDED WITH THE GENERATOR SET

- A. Provide and install a 20-light LED type remote alarm annunciator with horn, located as shown on the drawings or in a location that can be conveniently monitored by facility personnel. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems for the local generator control panel. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2. The interconnecting wiring between the annunciator and other system components shall be monitored and failure of the interconnection between components shall be displayed on the annunciator panel.
- B. The annunciator shall include the following alarm labels, audible annunciation features, and lamp colors:

<u>Condition</u>	<u>Lamp Color</u>	<u>Audible Alarm</u>
Normal Power (to Loads)	Green	No
Genset Supplying Load	Amber	No
Genset Running	Green	No
Not in Auto	Red	Yes
	(Flashing)	
High Battery Voltage	Red	Yes
Low Battery Voltage	Red	Yes

Charger AC Failure	Red	Yes
Fail to Start	Red	Yes
Low Engine Temperature	Amber	Yes
Pre-High Engine Temperature	Amber	Yes
High Engine Temperature	Red	Yes
Pre-Low Oil Pressure	Amber	Yes
Low Oil Pressure	Red	Yes
Overspeed	Red	Yes
Low Coolant Level	Amber	Yes
Low Fuel Level	Amber	Yes
Network OK	Green	Yes
(4) Spares	Configurable	Configurable

Low battery voltage lamp shall also be lighted for low cranking voltage or weak battery alarm.

- C. The generator set shall be provided with a mounted main line circuit breaker, sized to carry the rated output current of the generator set. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

D. Outdoor Weather-Protective Enclosure

1. The generator set shall be provided with an outdoor enclosure, with the entire package listed under UL2200. The package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing. The total assembly of generator set, enclosure, and sub-base fuel tank (when used) shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 100F. The housing shall have hinged access doors as required to maintain easy access for all operating and service functions. All doors shall be lockable, and include retainers to hold the door open during service. Enclosure roof shall be cambered to prevent rainwater accumulation. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.
2. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturers standard color using a two step electrocoating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:

Primer thickness, 0.5-2.0 mils. Top coat thickness, 0.8-1.2 mils.

Gloss, per ASTM D523-89, 80% plus or minus 5%. Gloss retention after one year shall exceed 50%.

Crosshatch adhesion, per ASTM D3359-93, 4B-5B.

Impact resistance, per ASTM D2794-93, 120-160 inch-pounds.

Salt Spray, per ASTM B117-90, 1000+ hours.



Humidity, per ASTM D2247-92, 1000+ hours.

Water Soak, per ASTM D2247-92, 1000+ hours.

3. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
  4. Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.
  5. A factory-mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections.
  6. The enclosure shall include the following maintenance provisions:
    - Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves
    - External radiator fill provision.
- E. Provide a sub-base fuel tank for the generator set, sized to allow for full load operation of the generator set for 24 hours. The sub-base fuel tank shall be UL142 listed and labeled. Installation shall be in compliance to NFPA37. The fuel tank shall be a double-walled, steel construction and include the following features:
1. Emergency tank and basin vents.
  2. Mechanical level gauge.
  3. Fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by the engine manufacturer and in compliance to UL2200 and NFPA 37 requirements.
  4. Leak detection provisions, wired to the generator set control for local and remote alarm indication.
  5. High and low level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level
  6. Basin drain.
  7. Integral lifting provisions.

## PART 3. EXECUTION

### 3.01 SEQUENCE OF OPERATION

- A. Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control. The generator set shall complete a time delay start period as programmed into the control.
- B. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:
- C. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate “fail to crank” shutdown.
- D. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate “fail to start”.
- E. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
- F. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous state.
- G. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.
- H. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.
- I. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

### 3.02 OTHER REQUIREMENTS

- A. Factory Testing
  - 1. The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.
  - 2. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

### 3.03 INSTALLATION

- A. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- C. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- D. Equipment shall be initially started and operated by representatives of the manufacturer.
- E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

#### 3.04 ON-SITE ACCEPTANCE TEST:

- A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.
- B. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

#### 3.05 TRAINING

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

#### 3.06 SERVICE AND SUPPORT

- A. The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.
- B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
- C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

#### 3.07 WARRANTY

- A. The generator set and associated equipment shall be warranted for a period of not less than 5 years from the date of commissioning against defects in materials and workmanship.
- B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION

## **SECTION 16300 AUTOMATIC TRANSFER SWITCH**

### **PART 1 - GENERAL**

#### **1.01 WORK INCLUDED**

- A. Automatic Transfer Switches

#### **1.02 SYSTEM**

- A. Furnish the automatic transfer switches to automatically transfer between the normal and emergency power source.

#### **1.03 APPLICABLE STANDARDS**

- A. The automatic transfer switches covered by these specifications shall be designed, tested, and assembled in strict accordance with all applicable standards of ANSI, U.L., IEEE and NEMA.

#### **1.04 SUBMITTALS**

- A. Manufacturer shall submit shop drawings for review, which shall include the following, as a minimum:
  - 1. Descriptive literature
  - 2. Plan, elevation, side, and front view arrangement drawings, including overall dimension, weights and clearances, as well as mounting or anchoring requirements and conduit entrance locations.
  - 3. Schematic diagrams.
  - 4. Wiring diagrams.
  - 5. Accessory list.

### **PART 2 - PRODUCTS**

#### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Russelectric
- B. ASCO
- C. Zenith

#### **2.02 CONSTRUCTION**

- A. General
  - 1. The automatic transfer switch shall be furnished as shown on the drawings. Voltage and continuous current ratings and number of poles shall be as

shown. The automatic transfer switch shall be Service Entrance Rated, unless otherwise indicated

2. On 3 phase, 4 wire systems, utilizing ground fault protection, a true 4-pole switch shall be supplied with all four poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles.
3. The transfer switch shall be mounted in a NEMA 1 enclosure, unless otherwise indicated. Enclosures shall be fabricated from 12-gauge steel. The enclosure shall be sized to exceed minimum wire bending space required by UL 1008.
4. The transfer switch shall be equipped with an internal welded steel pocket, housing an operations and maintenance manual.
5. The transfer switch shall be top and bottom accessible.
6. The main contacts shall be capable of being replaced without removing the main power cables.
7. The main contacts shall be visible for inspection without any major disassembly of the transfer switch.
8. All bolted bus connections shall have Belleville compression type washers.
9. When a solid neutral is required, a fully rated bus bar with required AL-CU neutral lugs shall be provided.
10. Control components and wiring shall be front accessible. All control wires shall be multiconductor 18 gauge 600-volt SIS switchboard type point to point harness. All control wire terminations shall be identified with tubular sleeve-type markers.
11. The switch shall be equipped with 90 degrees C rated copper/aluminum solderless mechanical type lugs.
12. The complete transfer switch assembly shall be factory tested to ensure proper operation and compliance with the specification requirements. A copy of the factory test report shall be available upon request.

B. Automatic Transfer Switch

1. The transfer switch shall be double throw, actuated by a single electrical operator momentarily energized, and connected to the transfer mechanism by a simple over center type linkage. Total transfer time shall not exceed one half second
2. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in both the normal and emergency positions without the use of hooks, latches, magnets, or springs, and shall be silver-

tungsten alloy. Separate arcing contacts with magnetic blowouts shall be provided on all transfer switches. Interlocked, molded case circuit breakers or contactors are not acceptable.

3. The transfer switch shall be equipped with a safe external manual operator, designed to prevent injury to operating personnel. The manual operator shall provide the same contact to contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly. The external manual operator shall be safely operated from outside of the transfer switch enclosure while the enclosure door is closed.

C. Automatic Transfer Switch Controls

1. The transfer switch shall be equipped with a microprocessor based control system, to provide all the operational functions of the automatic transfer switch. The controller shall have two asynchronous serial ports. The controller shall have a real time clock with NiCad battery back up.
2. The CPU shall be equipped with self diagnostics which perform periodic checks of the memory I/O and communication circuits, with a watchdog/power fail circuit
3. The controller shall use industry standard open architecture communication protocol for high-speed serial communications via multidrop connection to other controllers and to a master terminal with up to 4000 ft of cable, or further, with the addition of a communication repeater. The serial communication port shall be RS422/485 compatible.
4. The serial communication port shall allow interface to either the manufacturers or owner furnished remote supervisory control.
5. The controller shall have password protection required to limit access to qualified and authorized personnel.
6. The controller shall include a 20 character, LCD display, with a keypad, which allows access to the system.
7. The controller shall include three-phase over/under voltage, over/under frequency, phase sequence detection and phase differential monitoring on both normal and emergency sources.
8. The controller shall be capable of storing the following records in memory for access either locally or remotely:
  - a. Number of hours transfer switch is in the emergency position (total since record reset).
  - b. Number of hours emergency power is available (total since record reset).
  - c. Total transfer in either direction (total since record reset).

- d. Date, time, and description of the last four source failures.
- e. Date of the last exercise period.
- f. Date of record reset.

D. Sequence of Operation

1. When the voltage on any phase of the normal source drops below 80% or increases to 120%, or frequency drops below 90%, or increase to 110%, or 20% voltage differential between phases occurs, after a programmable time delay period of 0-9999 seconds factory set at 3 seconds to allow for momentary dips, the engine starting contacts shall close to start the generating plant.
2. The transfer switch shall transfer to emergency when the generating plant has reached specified voltage and frequency on all phases.
3. After restoration of normal power on all phases to a preset value of at least 90% to 110% of rated voltage, and at least 95% to 105% of rated frequency, and voltage differential is below 20%, an adjustable time delay period of 0-9999 seconds (factory set at 300 seconds) shall delay retransfer to allow stabilization of normal power. If the emergency power source should fail during this time delay period, the switch shall automatically return to the normal source.
4. After retransfer to normal, the engine generator shall be allowed to operate at no load for a programmable period of 0-9999 seconds, factory set at 300 seconds.

E. Automatic Transfer Switch Accessories

1. Programmable three phase sensing of the normal source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.
2. Programmable three phase sensing of the emergency source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases set at 20%, and phase sequence monitoring.
3. Time delay for override of momentary normal source power outages (delays engine start signal and transfer switch operation). Programmable 0-9999 seconds. Factory set at 3 seconds, if not otherwise specified.
4. Time delay on retransfer to normal, programmable 0-9999 seconds, factory set at 300 seconds if not otherwise specified, with overrun to provide



programmable 0-9999 second time delay, factory set at 300 seconds, unloaded engine operation after retransfer to normal.

5. Time delay on transfer to emergency, programmable 0-9999 seconds, factory set at 3 seconds.
6. A maintained type load test switch shall be included to simulate a normal power failure, keypad initiated.
7. A remote type load test switch shall be included to simulate a normal power failure, remote switch initiated.
8. A time delay bypass on retransfer to normal shall be included. Keypad initiated.
9. Contact, rated 10 Amps 30 volts DC, to close on failure of normal source to initiate engine starting.
10. Contact, rated 10 Amps 30 volts DC, to open on failure of normal source for customer functions.
11. Light emitting diodes shall be mounted on the microprocessor panel to indicate: switch is in normal position, switch is in emergency position and controller is running.
12. A plant exerciser shall be provided with (10) 7-day events, programmable for any day of the week and (24) calendar events, programmable for any month/day, to automatically exercise generating plant programmable in one-minute increments. Also include selection of either "no load" (switch will not transfer) or "load" (switch will transfer) exercise period. Keypad initiated.
13. Provision to select either "no commit" or "commit" to transfer operation in the event of a normal power failure shall be included. In the "no commit position," the load will transfer to the emergency position unless normal power returns before the emergency source has reach 90% of it's rated values (switch will remain in normal). In the "commit position" the load will transfer to the emergency position after any normal power failure. Keypad initiated.
14. Two auxiliary contacts rated 10 Amp, 120 volts AC (for switches 100 to 800 amps) 15 amp, 120 volts AC (for switches 1000 to 4000 amps), shall be mounted on the main shaft, one closed on normal, the other closed on emergency. Both contacts will be wired to a terminal strip for ease of customer connections.
15. A three phase digital LCD voltage readout, with 1% accuracy shall display all three separate phase to phase voltages simultaneously, for both the normal and emergency source.
16. A digital LCD frequency readout with 1% accuracy shall display frequency for both normal and emergency source.

17. An LCD readout shall display normal source and emergency source availability.

F. The following accessories shall be available by simple activation, via the keypad:

1. Include (2) time delay contacts that open simultaneously just (milliseconds) prior to transfer in either direction. These contacts close after a time delay upon transfer. Programmable 0-9999 seconds after transfer.
2. A block transfer function shall be included, energized from a 24VDC signal from the generator control switchgear, to allow transfer to emergency.
3. A load-shed function shall be included, energized from a 24VDC signal from the generator control switchgear, to disconnect the load from the emergency source when an overload condition occurs.
4. A peak shave function shall be included, energized from a 24VDC signal from the generator control switchgear. This function will start the emergency generator and transfer the ATS to the emergency source reducing the utility supply to the building. After the peak shave signal is removed, the transfer switch will retransfer to the normal supply, bypassing the retransfer time delay.

G. Approval

1. As a condition of approval, the manufacturer of the automatic transfer switches shall verify that their switches are listed by Underwriters Laboratories, Inc., Standard UL-1008 with 3 cycle short circuit closing and withstand as follows:

RMS Symmetrical Amperes 480 VAC

<u>Amperes</u>	<u>Current Limiting Closing and Withstand</u>	<u>Fuse Rating</u>
100 – 400	42,000	200,000
600 – 800	65,000	200,000
1000 – 1200	85,000	200,000
1600 – 4000	100,000	200,000

2. During the 3 cycle closing and withstand tests, there shall be no contact welding or damage. The 3 cycle tests shall be performed without the use of current limiting fuses. The test shall verify that contact separation has not occurred, and there is contact continuity across all phases. Test procedures shall be in accordance with UL-1008, and testing shall be certified by Underwriters' Laboratories, Inc.
3. When conducting temperature rise tests to UL-1008, the manufacture shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.
4. The microprocessor controller shall meet the following requirements:

- Storage conditions - 25 degrees C to 85 degrees C
  - Operation conditions - 20 degrees C to 70 degrees C ambient
  - Humidity 0 to 99% relative humidity, noncondensing
  - Capable of withstanding infinite power interruptions
  - Surge withstand per ANSI/IEEE C-37.90A-1978
5. Manufacturer shall provide copies of test reports upon request.
- H. Manufacturer
1. The transfer switch manufacturer shall employ a nationwide factory-direct, field service organization, available on a 24-hour a day, 365 days a year, call basis.
  2. The manufacture shall include an 800-telephone number, for field service contact, affixed to each enclosure.
  3. The manufacturer shall maintain records of each transfer switch, by serial number, for a minimum 20 years.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. Automatic Transfer Switches shall be provided with adequate lifting means for ease of installation of wall or floor mounted enclosures.
- B. Provide access and working space as indicated or as required.

#### 3.02 ADJUSTMENTS

- A. Tighten assembled bolted connections with appropriate tools to manufacturer's torque recommendations prior to first energization.

END OF SECTION

**SECTION T-16441**  
**DISCONNECT SWITCHES**

**PART 1      GENERAL**

**1.01    SCOPE**

- A.    The Contractor shall furnish and install the low-voltage fused and non-fused switches as specified herein and as shown on the contract drawings.

**1.02    RELATED SECTIONS**

**1.03    REFERENCES**

- A.    The switches and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA and UL.

**1.04    SUBMITTALS -- FOR REVIEW/APPROVAL**

- A.    Procedure: Submit in accordance with Section 01300, 16010, and as stated herein.
- B.    The following information shall be submitted to the Engineer:
  - 1.    Master drawing index
  - 2.    Dimensioned outline drawing
  - 3.    Conduit entry/exit locations
  - 4.    Switch ratings including:
    - a.    Short-circuit rating
    - b.    Voltage
    - c.    Continuous current
  - 5.    Fuse ratings and type
  - 6.    Cable terminal sizes.

**1.05    SUBMITTALS -- FOR INFORMATION**

- A.    When requested by the Engineer the following product information shall be submitted:
  - 1.    Descriptive bulletins
  - 2.    Product sheets.

**1.06    SUBMITTALS--FOR CLOSEOUT**

- A.    The following information shall be submitted for record purposes:
  - 1.    Final as-built drawings and information for items listed in section 1.04

## 1.07 QUALIFICATIONS

- A. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.

## 1.08 NOT USED

## 1.09 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

## A. FIELD MEASUREMENTS

- A. Contractor shall field verify all dimensions prior to installation. Installation of all switches shall comply with the National Electric Codes clearance and mounting height requirements.

## B. OPERATION AND MAINTENANCE MANUALS

- A. Three (3) copies of these instruction manuals shall be submitted with the closeout documents listed in section 1.06.

# PART 2 PRODUCTS

## 2.01 MANUFACTURERS

- A. Cutler-Hammer
- B. Square D
- C. Siemens

## 2.02 DISCONNECT SWITCHES

- A. Provide switches as shown on drawings, with the following ratings:
  - 1. 30 to 1200 amperes
  - 2. 250 volts AC, DC; 600 volts AC (30A to 200A 600 volts DC)
  - 3. 2, 3, 4, and 6 poles
  - 4. Non-Fusible and Fusible
  - 5. Copper/aluminum standard mechanical lugs.
- B. Construction
  - 1. Switchblades and jaws shall be plated copper.
  - 2. Switches shall have a handle that is easily pad lockable in the OFF position.

3. Switches shall have defeat-able door interlocks that prevent the door from opening when the handle is in the ON position.
4. Switch assembly and operating handle shall be an integral part of the enclosure base.
5. Fusible switches rated 100A to 1200A shall have reinforced fuse clips.
6. Switch blades shall be readily visible in the OFF position.
7. Switch operating mechanism shall be non-teasible, positive quick-make/quick-break type (except 30A plug fuse-type).
8. Fusible switches shall be suitable for service entrance equipment.
9. Switches shall have line terminal shields.
10. All exterior switches shall be heavy-duty type.
11. All interior switches shall be general-duty type unless otherwise noted.

C. Enclosures

- A. Exterior: All enclosures shall be NEMA 3R rainproof unless otherwise noted.
- B. Interior: All enclosures shall be NEMA 1 unless otherwise noted.

D. Fuses

1. Fuses shall be dual element, current limiting type such as Bussmann Low-Peak Yellow or equal.

2.04 NAMEPLATES

- A. Manufacturers nameplates shall be front cover mounted, contain a permanent record of switch type, ampere rating, and maximum voltage rating.

PART 3 EXECUTION

A. EXAMINATION

- A. All switches shall be cleaned free of debris after installation and prior to final acceptance by the owner. Remove all miscellaneous paint markings, grease and tar.

3.02 FACTORY TESTING

- A. Standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.

3.03 INSTALLATION

- A. The equipment shall be installed per the manufacturer's recommendations.

END OF SECTION

**SECTION 16442**  
**LOW VOLTAGE PANELBOARDS**

**PART 1 GENERAL**

**1.01 SCOPE:**

- A. Furnish and install panelboards as specified herein and as indicated on the drawings.
- B. Panelboard types included in this Section are:
  - 1. Power distribution panelboards
  - 2. Lighting and appliance panelboards

**1.02 REFERENCES:**

- A. National Electrical Contractors Association (NECA)
  - 1. Standard of Installation
- B. National Electrical Manufacturers Association (NEMA)
  - 1. AB 1            Molded Case Circuit Breakers
  - 2. PB 1           Panelboards
  - 3. PB1.1        General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- C. Underwriters Laboratories Inc. (UL)
  - 1. 50            Cabinets and Boxes
  - 2. 67           Panelboards

**1.03 SUBMITTALS - FOR APPROVAL:**

- A. Procedure: Submit in accordance with Section 01300, 16010, and as stated herein.
- B. Product Data:
  - 1. Descriptive bulletins
  - 2. Enclosure outline drawing with complete dimensions
  - 3. Breaker layout drawing
  - 4. Component list
  - 5. Conduit entry/exit locations
  - 6. Assembly ratings including:
    - a. Short circuit current
    - b. Voltage
    - c. Continuous current
  - 7. Cable terminal sizes.
  - 8. Installation Instructions



1.04 SUBMITTALS – RECORD DATA:

- A. Procedure: Submit in accordance with Section 01300.
- B. The following information shall be submitted for record purposes:
  - 1. Final (as-built) drawings and information for items listed in Paragraph 1.03
  - 2. Installation, operation and maintenance instruction
  - 3. Spare parts list

1.05 QUALIFICATIONS:

- A. The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers.
- B. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

- A. Cutler-Hammer
- B. Square D
- C. Siemens

2.02 RATINGS:

- A. Panelboards rated 240 Vac or less shall have short circuit ratings as indicated on the drawings or as herein scheduled, but not less than 10,000 amperes RMS symmetrical.
- B. Panelboards rated 480 Vac shall have short circuit ratings as indicated on the drawings or as herein scheduled, but not less than 14,000 amperes RMS symmetrical.
- C. Panelboards shall be labeled with a UL short circuit rating. All panelboards shall be fully rated. Series ratings shall not be used.

2.03 CONSTRUCTION:

- A. Interiors shall be completely factory assembled devices. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.

- B. Trims for lighting and appliance panelboards shall be supplied with a hinged door covering all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semiflush, cylinder lock and catch assembly. Doors over 48 inches in height shall have auxiliary fasteners.
- C. Distribution panelboard trims shall cover all live parts. Switching device handles shall be accessible.
- D. Surface trims shall be same height and width as box. Flush trims shall overlap the box by 3/4 inch on all sides. Trims shall be secured to box with concealed clamps.
- E. A directory card with a clear plastic cover shall be supplied and mounted on the inside of each door in a metal frame.
- F. All locks shall be keyed alike.

#### 2.04 BUS:

- A. Main bus bars shall be tin-plated copper, sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 65<sup>0</sup> C above an ambient of 40<sup>0</sup> C maximum.
- B. A bolted ground bus shall be included in all panels.
- C. Full-size (100%-rated) insulated neutral bars shall be included for panelboards indicated to have a neutral bus. Bus bar taps for panels with single-pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection. 200%-rated neutrals shall be supplied for panels designated on drawings with oversized neutral conductors.

#### 2.05 DISTRIBUTION PANELBOARDS:

- A. Distribution panelboards including circuit breakers contained therein shall have fully rated interrupting ratings as indicated on the drawings. Panelboards shall have bolt-on, molded case circuit breakers as indicated below.
- B. Molded case circuit breakers shall provide circuit overcurrent protection with inverse time and instantaneous tripping characteristics. Ground fault protection shall be provided where indicated.
- C. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break, over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy and arc extinction shall be accomplished by means of arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
- D. Where indicated, circuit breakers shall be current limiting.

- E. Circuit breakers below 600-ampere shall have thermal-magnetic trip units and inverse time-current characteristics.
- F. Circuit breakers 600-ampere through 1200-ampere shall be provided with microprocessor-based RMS sensing trip units.
  - 1. Each molded case circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit, and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.
  - 2. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed or adjustable as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
  - 3. The microprocessor-based trip unit shall have thermal memory capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.
  - 4. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override. Internal ground fault protection adjustable pick-up ratings shall not exceed 1200 amperes. Provide neutral ground fault current sensor for four-wire loads.
  - 5. Breakers shall have built-in test points for testing the long-time delay, instantaneous, and ground fault functions of the breaker, by means of a 120-volt operated test set. Provide one test set capable of testing all breakers 600-ampere and above.
  - 6. System coordination shall be provided by the following microprocessor-based, time-current curve shaping adjustments:
    - Adjustable long-time pick-up
    - Adjustable short-time pick-up and delay, with selective curve shaping
    - Adjustable instantaneous pick-up
    - Adjustable ground fault pick-up and delay, with selective curve shaping.
- G. Where indicated, provide circuit breakers UL listed for application at 100% of their continuous ampere rating in their intended enclosure.
- H. Provide shunt trips, bell alarms, and auxiliary switches as indicated on the drawings.
- I. Circuit breakers supplying air conditioning branch circuits shall be UL listed as type HACR.

## 2.06 LIGHTING AND APPLIANCE PANELBOARDS:

- A. The minimum integrated short circuit rating for branch circuit panelboards shall be indicated on the drawings.
- B. Bolt-in type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.
- C. Circuit breakers shall be thermal magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100-ampere frame and through 100-ampere trip sizes shall take up the same pole spacing. Circuit breakers shall be UL listed as type SWD for lighting circuits and HACR for air conditioning branch circuits.
  - 1. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management and control system (EMCS) panels and fire alarm panels.

## 2.07 ENCLOSURE:

- A. General: Enclosures shall be at least 20 inches wide and made from galvanized steel. Provide minimum gutter space in accordance with the National Electrical Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided. Enclosures shall be provided with blank ends.
- B. Rating: NEMA type 12 enclosure except where other enclosure requirements are indicated.

## 2.08 FINISH:

- A. Surfaces of the trim assembly shall be properly cleaned, primed, and a finish coat of the manufacturers standard paint color shall be applied.

## 2.09 MISCELLANEOUS DEVICES

- A. Provide TVSS system integral to distribution panelboards and appliance panelboards where indicated on drawings. Reference section 16671 for specifications on TVSS units.

## PART 3 EXECUTION

### 3.01 EXAMINATION:

- A. Confirm installation space and clearance requirements for panelboards in accordance with NEC requirements.

### 3.02 INSTALLATION:

- A. General: Install panelboards as indicated on the drawings and in accordance with manufacturer's published instructions, NEMA PB 1.1, and NECA "Standard of Installation".
- B. Mounting Heights: Top of trim 6 feet 2 inches above finished floor, except as otherwise indicated.
- C. Mounting:
  - 1. Plumb and rigid without distortion of box.
  - 2. Mount flush panels uniformly flush with wall finish.
- D. Circuit Directory: Typed directory indicating final circuit connections. Obtain approval before installing.
- E. Install filler plates in unused breaker spaces.
- F. Provisions for Future Circuits at Flush Panelboards:
  - 1. Stub four 1-inch empty conduits from panel into accessible ceiling space or space designated to be ceiling space in future.
  - 2. Stub four 1-inch empty conduits into raised floor space or below slab other than slabs on grade.
- G. Wiring in Panel Gutters: Train conductors neatly in groups, bundle, and wrap with wire ties after completion of load balancing.

### 3.03 IDENTIFICATION:

- A. Identify field-installed wiring and components and provide unit nameplate in accordance with Section 16075.
- B. Provided one (1) 8-1/2"x11" stainless steel nameplate engraved with one-line diagram and year installed. One-line diagram shall include panel voltages, amps, AIC ratings, and feeder sizes. Nameplate shall be mounted to the exterior door of the main distribution panel – LB.

### 3.04 GROUNDING:

- A. Connections: Make equipment grounding connections for panelboards as required in Section 16060.
- B. Provide ground continuity to main electrical ground bus.
- C. Provide isolated ground bars for panels serving sensitive electronic equipment and as indicated on panel schedules.

### 3.05 CONNECTIONS:

- A. Tighten electrical connectors and terminals, including grounding connections, in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.06 FIELD TESTING:

- A. Inspect for compliance with drawings and specifications.
- B. Inspect for defects, damaged or missing parts.
- C. Operate each breaker a minimum of three (3) times to insure proper operation.
- D. Perform insulation resistance test on complete assembly at 1000 Vdc. Disconnect any solid-state devices prior to testing. Minimum acceptable test results are 100 megohms.

3.07 CLEANING:

- A. Upon completion of installation, inspect interior and exterior of panelboards.
- B. Remove paint splatters and other spots, dirt, and debris.
- C. Touch up scratches and mars of finish to match original finish.
- D. Clean interior of panelboard.

3.08 FIELD ADJUSTMENTS:

- A. Balancing Loads: Prior to final acceptance, conduct load-balancing measurements and circuit changes as follows:
  - 1. Perform measurements during period of normal working load as advised by Owner.
  - 2. Advise Engineer of load imbalances exceeding 20% or of loads exceeding 80% of circuit ratings. Reconnect branch circuit loads as directed by Engineer.
  - 3. Perform load-balancing circuit changes outside the normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical circuits.
  - 4. Recheck loads after circuit changes during normal load period. Record load readings before and after changes and submit test records.

END OF SECTION

## **SECTION T-16510 LUMINAIRES**

### **PART I GENERAL**

#### **1.01 SUMMARY:**

##### **A. Section Includes:**

1. Lighting fixtures
2. Lamps
3. Ballasts
4. Emergency lighting units

#### **1.02 REFERENCES:**

##### **A. American National Standards Institute (ANSI):**

1. C78 Series Lamps
2. C82.1-97 Electric Lamp Ballast - Line Frequency Fluorescent Lamp Ballast
3. C82.2-84 Fluorescent Lamp Ballasts - Methods of Measurements
4. C82.4-92 Ballasts for High Intensity Discharge and Low-Pressure Sodium Lamps (Multiple Supply Type)
5. C82.11-93 High Frequency Fluorescent Lamp Ballasts

##### **B. Institute of Electrical and Electronics Engineers (IEEE):**

1. C62.11-93 IEEE Recommended Practice on Metal Oxide Surge Arresters for Alternating Current Power Circuits

##### **C. National Fire Protection Association (NFPA):**

1. 70 National Electrical Code

##### **D. Underwriters Laboratories Inc. (UL):**

1. 844-95 Electric Lighting Fixtures for Use in Hazardous (Classified) Locations
2. 924-95 Emergency Lighting and Power Equipment
3. 935-95 Fluorescent Lamp Ballast
4. 1029-94 High Intensity Discharge Lamp Ballasts
5. 1570-95 Fluorescent Lighting Fixtures
6. 1571-95 Incandescent Lighting Fixtures
7. 1572-97 High Intensity Discharge Lighting Fixtures

#### **1.03 DEFINITIONS:**

- A. Emergency Lighting Unit: Fixture with integral emergency battery power supply and means for controlling and charging battery. Emergency units are available with integral lamps only.
- B. Fixture: Complete lighting unit, exit sign, or emergency lighting unit. Fixtures include lamps and parts required to distribute light, position and protect lamps, and connect lamps to power supply. Internal battery powered exit signs and emergency lighting units also include battery and means for controlling and recharging battery. Emergency lighting units are available with and without integral lamp heads and lamps.
- C. Luminaire: Fixture.
- D. Average Life: Time after which 50% will have failed and 50% will have survived under normal conditions.
- E. Total Harmonic Distortion (THD): The root mean square (RMS) of all the harmonic current components divided by total fundamental (60 hz) current.

#### 1.04 SUBMITTALS:

- A. Procedures: Submit in accordance with Section 01300, 16010, and as stated herein.
- B. Product Data:
  - 1. Describe fixtures, lamps, ballasts, and emergency lighting units. Arrange product data for fixtures in order of fixture designation. Include data on features and accessories and the following information:
    - a. Outline drawings of fixtures indicating dimensions and principal features.
    - b. Electrical ratings and photometric data with specified lamps and certified results of independent laboratory tests.
    - c. Data on batteries and chargers of emergency lighting units.
- C. Shop Drawings:
  - 1. Detail nonstandard fixtures indicating dimensions, weights, methods of field assembly, components, features, and accessories.
- D. Supplies:
  - 1. Submit sample of fixture if different than specified.
- E. Miscellaneous:



1. For substitutes only, product certifications signed by manufacturers of lighting fixtures certifying that their fixtures comply with specified requirements.
2. Warranty for rechargeable battery.
3. Coordination drawings for fixtures that require coordination with other equipment installed in the same space.

#### 1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from damage.
- B. Store lighting fixtures in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity; laid flat and blocked off ground.
- C. Handle lighting fixtures carefully to prevent damage, breaking, and scarring of finishes. Do not install damaged units or components; replace with new.

#### 1.06 QUALITY ASSURANCE:

- A. Items provided under this section shall be listed and labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).
  1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
  2. Terms "listed and "labeled" shall be as defined in National Electrical Code, Article 100.
- B. Regulatory Requirements:
  1. National Electrical Code: Components and installation shall comply with NFPA 70.
- C. Coordinate fixtures mounting hardware and trim with ceiling system.

### PART 2 PRODUCTS

#### 2.01 FIXTURES, GENERAL:

- A. Comply with requirements specified in Paragraphs below and lighting fixture schedule.

#### 2.02 FIXTURE COMPONENTS, GENERAL:

- A. Metal Parts: Free from burrs, sharp corners and edges.
- B. Sheet Metal Components: Steel, except as indicated. Form and support components to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating and free from light leakage under operating conditions. Arrange to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers and other pieces to prevent accidental falling during relamping and when secured in operating position.
- D. Reflecting Surfaces: Minimum reflectances as follows, except as otherwise indicated:
  - 1. White Surfaces: 85%
  - 2. Specular Surfaces: 83%
  - 3. Diffusing Specular Surfaces: 75%
  - 4. Laminated Silver Metallized Film: 90%
- E. Lenses, Diffusers, Covers, and Globes: 100% virgin acrylic plastic or water white, annealed crystal glass except as indicated.
  - 1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat and UV radiation.
  - 2. Lens Thickness: 0.125 inch, minimum.

#### 2.03 SUSPENDED FIXTURE SUPPORT COMPONENTS:

- A. Single-Stem Hangers: ½-inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.
- B. Twin-Stem Hangers: Two, ½-inch steel tubes with single canopy arranged to mount single fixture. Finish same as fixture.
- C. Rod Hangers: ¼-inch diameter cadmium plated, threaded steel rod.
- D. Hook Hanger: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord and locking-type plug.

#### 2.04 FLUORESCENT FIXTURES:

- A. Fixtures: Conform to UL 1570.
- B. Ballasts: Electronic type. Conform to UL 935, ANSI C82.11 and NFPA 70.
  - 1. Certification: By Electrical Testing Laboratory (ETL).
  - 2. Labeling: By Certified Ballast Manufacturers Association (CBM).
  - 3. Type: Class P, 0.95 P.F. minimum.
  - 4. Sound Rating: "A" rating, except as indicated otherwise.

5. Voltage: Match connected circuits.
  6. Temperature: Start and operate at minimum of 50° F.
  7. THD: 10 percent maximum.
- C. Low Temperature Ballast: Start and maintain operation at a minimum of 0° F.
- D. T-8 Lamp Ballasts: Full-light output type, compatible with energy-saving lamps. Following are required average input wattages when tested according to ANSI C82.2.
1. 39 or less when operating one F32T8 lamp.
  2. 62 or less when operating two F32T8 lamps.
  3. 95 or less when operating three F32T8 lamps.
  4. 114 or less when operating four F32T8 lamps.
- E. Recessed fluorescent fixtures shall have 100% acrylic prismatic lenses with a minimum thickness of 0.125 inch unless otherwise indicated.

#### 2.05 HIGH INTENSITY DISCHARGE (HID) FIXTURES:

- A. Fixtures: Conform to UL 1572.
- B. Ballasts: Conform to UL 1029 and ANSI C82.4. Provide ballasts with following features, except as otherwise indicated.
1. Constant wattage autotransformer (CWA) or regulator, high-power-factor type.
  2. Voltage rating matches system voltage.
  3. Single-Lamp Ballasts: Minimum starting temperature of -30° C.
  4. Normal ambient operating temperature is 40° C.
  5. Open circuit operation will not reduce average life.
  6. Noise Suppression: Manufacturer's standard epoxy encapsulated model designed to minimize audible fixture noise.

#### 2.06 INCANDESCENT FIXTURES:

- A. Conform to UL 1571.

#### 2.07 FIXTURES FOR HAZARDOUS LOCATIONS:

- A. Conform to UL 844 or provide units that have Factory Mutual Engineering and Research Corporation (FM) certification for indicated class and division of hazard.

#### 2.08 EXIT SIGNS:

- A. Conform to UL 924.

1. Sign Colors: Conform to local code.
- B. Self-Powered Exit Signs (Battery Backup): Integral automatic high/low trickle charger in self-contained power pack.
  1. Battery: Sealed, maintenance-free, nickel cadmium type 1.5 hour minimum emergency run time.

## 2.09 EMERGENCY LIGHTING UNITS:

- A. Conform to UL 924. Provide self-contained units with features and characteristics as indicated on the drawings.

## 2.10 LAMPS:

- A. Conform to ANSI C78 series applicable to each type of lamp.
- B. Fluorescent Lamps: Color temperature of 3500° K.

## 2.11 FINISH:

- A. Steel Parts: Manufacturer's standard finish applied over corrosion-resistant primer, free of streaks, runs, holidays, stains, blisters and defects. Remove fixtures showing evidence of corrosion during project warranty period and replace with new fixtures.
- B. Other Parts: Manufacturer's standard finish.

## PART 3 EXECUTION

### 3.01 INSTALLATION:

- A. Set units plumb, square and level with ceiling and walls, in alignment with adjacent fixtures, and secure according to manufacturer's printed instructions and approved submittals.
- B. Mounting heights specified or indicated shall be to the bottom of fixture for ceiling-mounted fixtures and to the center of fixture for wall-mounted fixtures.
- C. Obtain approval of the exact mounting for lighting fixtures on the job prior to commencing installation and, where applicable, after coordinating with the type, style and pattern of ceiling being installed.
- D. Where recessed fixtures are supported by ceiling support grid, install additional support wires near each corner of the fixture.

- E. Make branch circuit wiring connections with conductors having an insulation temperature rating suitable for the fixture.
- F. Ground and bond fixtures in accordance with Section 16060.
- G. Install lamp units according to manufacturer's instructions and fixture schedule.

3.02 FIELD QUALITY CONTROL:

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Give 7-days notice of dates and times for field tests.
- C. Verify normal operation of each fixture after fixtures have been installed and circuits have been energized with normal power source.
- D. Interrupt electrical energy to demonstrate proper operation of emergency lighting installation.
  - 1. Duration of supply.
  - 2. Low battery voltage shut-down.
  - 3. Normal transfer to battery source and retransfer to normal.
  - 4. Low supply voltage transfer.
- E. Replace or repair malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.03 ADJUSTING AND CLEANING:

- A. Clean fixtures upon completion of installation. Use methods and materials recommended by manufacturer.
- B. Adjust aimable fixtures to provide required light intensities.
- C. Set and adjust photocells and/or time switches for proper operation as directed by Owner.

END OF SECTION

## **SECTION 16740 TELEPHONE/DATA SYSTEMS**

### **PART 1 – GENERAL**

#### **1.01 GENERAL**

- A. Applicable provisions of the General Conditions, Supplemental General Conditions and Special Conditions govern work under this Section.

#### **1.02 DESCRIPTION OF WORK**

- A. This section includes work required to provide a system of raceways, outlet boxes with covers, cables, connectors, terminations, terminal boards, and grounding to accommodate the installation under separate contract the telephone/data system equipment.

#### **1.03 RELATED SECTIONS**

- A. Division 16 – ELECTRICAL

#### **1.04 REFERENCES**

- A. National Electrical Code (NEC)

#### **1.05 SYSTEM DESCRIPTION**

- A. It is the intent of this Specification to provide a system of raceways and outlets to accommodate the installation of telephone and data cabling by the owner's vendor. The Contract Documents indicate the location and size of the main telephone service raceway and the location of telephone/data outlets and terminal boards. Routing of raceway system between outlets and terminal points shall be determined in the field by the contractor. Design of the system is based upon the premise that the telephone/data system installer will provide UL listed low smoke producing plenum cabling conforming to NEC requirements, permitting open wiring in plenum areas above accessible ceilings.

### **PART 2 – PRODUCTS**

#### **2.01 MATERIALS**

- A. Raceways: All raceways shall be furnished and installed in accordance with the requirements of this Section and Section 16136.
- B. Outlet Cover Plates: All outlet coverplates shall be in accordance with the requirements of Section 16140.
- C. Terminal Boards: Terminal boards shall be ¾-inch type Marine grade plywood having two coats of insulating oil base exterior enamel paint applied before installation on both sides and all edges. The quantity and dimensions shall be as indicated on the drawings.
- D. Cabling: By owner's vendor
- E. Jacks: By owner's vendor.

## PART 3 – EXECUTION

### 3.01 CONSTRUCTION

- A. Install terminal boards straight and level at locations indicated on drawings. Attach to masonry walls using expansion anchors, to CMU walls using toggle bolts, and to sheetrock and plaster walls using wood or sheet metal lag bolts fastened into the wall supporting the structure. The use of toggle bolts in sheetrock and plaster walls is not acceptable. Install anchors at a maximum of 24-inches on center at the perimeter of each board.
- B. At the main terminal board, stub-up the service entrance conduits at one end of the board within 3 inches of the supporting wall.
- C. Service entrance conduits shall be rigid galvanized steel or PVC encased in concrete with steel reinforced where it passes through the foundation and for at least 5' beyond the building line.
- D. Unless otherwise indicated, distribution raceways shall be electrical metallic tubing, except the PVC Schedule 40 may be used where raceway is buried in concrete slabs, columns, or beams. Provide insulating bushings at the ends of all raceways.
- E. The conduit size for each outlet shall be 1-inch minimum.
- F. Boxes shall be steel having the minimum dimensions of 4"x4"x2-1/8".
- G. Provide conduit from each outlet location to an accessible location above a lay-in type ceiling. Terminate conduit with bushing.
- H. Provide raceways sufficient to accommodate telephone cabling where passing through mechanical and electrical equipment rooms, pipe chases, mechanical chases, areas without ceilings (exposed structure), and nonaccessible areas such as ceiling plenums and crawl spaces.
- I. Provide 3/4-inch conduit with #6 AWG bare copper ground wire from main terminal location and bond to building grounding system as indicated on drawings.
- ~~J. Install cabling and terminate per TIA/EIA 568B using RJ45 jacks at both ends.~~
- K. Contact local telephone company to coordinate the exact telephone service entrance location and requirements prior to installing the telephone service raceways. All telephone company charges for service work shall be included in the contractor's bid.
- L. Refer to construction drawings for additional requirements.

END OF SECTION

## **SECTION 16750**

### **CABLE TV SYSTEMS**

#### **PART 1 – GENERAL**

##### **1.01 GENERAL**

- A. Applicable provisions of the General Conditions, Supplemental General Conditions and Special Conditions govern work under this Section.

##### **1.02 DESCRIPTION OF WORK**

- A. This section includes work required to provide a system of raceways, outlet boxes with covers, terminal boards, cabling, splitters, amplifiers, connectors, and grounding of a cable TV system.

##### **1.03 RELATED SECTIONS**

- A. Division 16 – ELECTRICAL

##### **1.04 REFERENCES**

- A. National Electrical Code (NEC)

##### **1.05 SYSTEM DESCRIPTION**

- A. It is the intent of this Specification to provide a system of raceways, cables and outlets to accommodate a complete working CATV system. The Contract Documents indicate the location and size of the main Cable service raceway and the location of TV outlets. Routing of raceway system between outlets and terminal points shall be determined in the field by the contractor. Design of the system is based upon the premise that the cable TV system installer will provide UL listed low smoke producing plenum cabling conforming to NEC requirements, permitting open wiring in plenum areas above accessible ceilings.

#### **PART 2 – PRODUCTS**

##### **2.01 MATERIALS**

- A. Raceways: All raceways shall be furnished and installed in accordance with the requirements of this Section and Section 16136.
- B. Outlet Cover Plates: Provide outlet coverplates in accordance with the requirements of Section 16140.
- C. Horizontal cabling: Provide RG6 coax cable that is U.L. Listed as low smoke producing plenum cabling conforming to the NEC requirements for open wiring in plenum areas above accessible ceilings. Provide cabling from each outlet to the closest IDF/MDF closet. Terminate cable on splitter/amplifier. Label cabling at both ends with the room number.
- D. CATV Backbone cable shall be RG11 coax cable that is U.L. Listed as low smoke producing plenum cabling conforming to the NEC requirements for open wiring in plenum areas above accessible ceilings. Provide cabling from each IDF closet to the MDF closet. Terminate cable(s) on splitter/amplifier. Label cabling at both ends with the room number.
- E. TV Outlets: Outlets shall be single port with type F connector. Terminal cable to outlet with proper RG6 connector.
- F. Splitters: Provide cable splitters in IDF and MDF rooms as required too interconnect all drops.
- G. Amplifiers: Provide amplifiers as required in IDF and MDF rooms as required too amplify signal.
- H. Terminal Boards: Terminal boards shall be ¾-inch type Marine grade plywood having two coats of insulating oil base exterior enamel paint applied before installation on both sides and all edges. The quantity and dimensions shall be as indicated on the drawings. Label terminal board "CATV".

#### **PART 3 – EXECUTION**

##### **3.01 CONSTRUCTION**



- A. Install terminal boards straight and level at locations indicated on drawings. Attach to masonry walls using expansion anchors, to CMU walls using toggle bolts, and to sheetrock and plaster walls using wood or sheet metal lag bolts fastened into the wall supporting the structure. The use of toggle bolts in sheetrock and plaster walls is not acceptable. Install anchors at a maximum of 24-inches on center at the perimeter of each board.
- B. At the main terminal board, stub-up the service entrance conduits at one end of the board within 3 inches of the supporting wall.
- C. Unless otherwise indicated, distribution raceways shall be electrical metallic tubing, except the PVC Schedule 40 may be used where raceway is buried in concrete slabs, columns, or beams. Provide insulating bushings at the ends of all raceways.
- D. The conduit size for each outlet shall be 3/4-inch minimum.
- E. Boxes shall be steel having the minimum dimensions of 4"x4"x2-1/8".
- F. Provide conduit from each outlet location to an accessible location above a lay-in type ceiling. Terminate conduit with bushing.
- G. Install RG6 cabling from each outlet to the closest IDF/MDF closet. Connect cables to splitters/amplifiers in IDF/MDF closets.
- H. Terminate cable at outlet with proper RG6 connector.
- I. Install RG11 cabling from each IDF closet to the MDF closet. Connect cables to splitters/amplifiers in the MDF closet as required.
- J. Terminate RG11 cable with proper connectors.
- K. Provide raceways sufficient to accommodate cabling where passing through mechanical and electrical equipment rooms, pipe chases, mechanical chases, areas without ceilings (exposed structure), and nonaccessible areas such as ceiling plenums and crawl spaces.
- L. Provide 3/4-inch conduit with #6 AWG bare copper ground wire from main terminal location and bond to building grounding system as indicated on drawings.
- M. Provide pull wire or mylar cord in any empty conduit.
- N. Coordinate final termination with the Architect, School District MIS department and the Local Cable TV provider.

END OF SECTION

2014

**GEOTECHNICAL ENGINEERING STUDY  
WEBB COUNTY MAIN FIRE STATION AND  
ADMINISTRATION BUILDING  
LAREDO, TEXAS**

**CONDUCTED FOR:**



**PREPARED BY:**



**1216 SANTA MARIA AVENUE  
LAREDO, TEXAS 78040  
TBPE REGISTRATION No. F-10341**



September 22, 2014

Mr. Mario A. Peña, A.I.A.  
Principal/Owner  
Hickey-Peña Architects, LLC  
919 Victoria Street  
Laredo, Texas 78040



Re: Geotechnical Engineering Study  
**Webb County Main Fire Station  
and Administration Building**  
**El Ranchito Road**  
**Laredo, Webb County, Texas**  
CET Project No.: 14G027

Dear Mr. Peña:

Castle Engineering & Testing, LLC (CET) has completed a geotechnical engineering exploration report for the proposed **Webb County New Main Fire Station and Administration Building** to be located within the Lake Casa Blanca International State Park controlled site limits in Laredo, Webb County, Texas.

We appreciate the opportunity to assist in this phase of the project, and we look forward for the opportunity to provide additional geotechnical and construction material testing services as the project progresses.

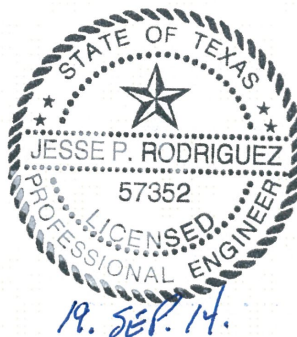
Please feel free to call us if you have any questions regarding this report or if we may be of further service.

Respectfully,

**Castle Engineering & Testing, LLC**

  
Jesse P. Rodriguez, P.E.  
President

JPR/mer-14G027



Copies Submitted: (3) Hickey-Peña Architects, LLC; Mr. Mario A. Peña, A.I.A.

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**APPENDIX**

## **1. INTRODUCTION**

### **1.1 Authorization and Scope**

Mr. Mario A. Peña, A.I.A., Principal/Owner of Hickey-Peña Architects, LLC, authorized this geotechnical engineering study. The purposes of this study were to determine and evaluate the stratification and engineering properties of the site subsurface soils and to develop geotechnical engineering recommendations and guidelines to be used in the design of the new pavement, preparation of the pavement subgrade, and other related ancillary items to be included in the construction documents for this project.

CET Scope of Services for this project consists of the following:

1. Drilling test borings at selected and accessible locations within the project site limits to determine and evaluate the stratification and engineering properties of the site subsurface soils and to determine groundwater conditions.
2. Perform the proper geotechnical laboratory tests on selected recovered samples to evaluate the physical engineering properties of the strata encountered.
3. Engineering analysis to develop geotechnical engineering design recommendations with respect to:
  - Foundation Design,
  - Pavement Design recommendations,
  - Construction Guidelines, and
  - Site, Subgrade, and Fill Preparation.

### **1.2 Project Description**

Based on the information provided to us by Hickey-Peña Architects, LLC, we understand that plans are underway to develop the Webb County Main Fire Station and Administration Building construction design documents. The proposed Improvements consist of:

- New Fire Station and Administration Building;
- New Parking Areas; and
- Site improvements in grading, drainage and utilities.

The structures may consist of pre-engineered metal frames with in-laid CMU wall sections and various exterior finishes, all supported by shallow or deep foundation systems. The roof system will be metal decking supported by steel roof joists, which will be supported on either interior concrete or steel pipe columns. Flexible and rigid materials will be considered for the final design pavement sections.

### 1.3 Climate

Laredo is located in a climatic zone described as hot during summer when temperatures tend to be in the 90's and cool during winter when temperatures tend to be below the 50's. The climatological data presented below was obtained from Weather Underground; average monthly temperatures for Laredo in degrees Fahrenheit and total monthly precipitation amounts in inches for the periods of 2012, 2013 and part of 2014 are shown below:

**Table No. 1- Average Monthly Temperatures and Precipitation for 2012**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp. (° F)	61	62	74	82	84	90	88	91	85	79	70	64
Actual Precip. (in.)	0.02	0.33	0.92	0.00	1.37	1.45	0.48	0.45	2.86	0.03	0.55	0.04
Average Precip. (in.)	0.00	0.01	0.04	0.00	0.05	0.06	0.03	0.02	0.10	0.00	0.02	0.00

**Table No. 2- Average Monthly Temperatures and Precipitation for 2013**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp. (° F)	60	66	71	76	81	88	88	90	83	78	64	56
Actual Precip. (in.)	0.44	0.31	0.00	1.74	2.41	2.01	2.44	0.23	3.35	3.81	0.15	1.24
Average Precip. (in.)	0.02	0.01	0.00	0.07	0.09	0.07	0.09	0.01	0.13	0.15	0.01	0.05

**Table No. 3- Average Monthly Temperatures and Precipitation for 2014**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp. (° F)	55	61	66	78	81	90	90	91	86*	N/A	N/A	N/A
Actual Precip. (in.)	0.01	0.08	0.96	0.03	3.71	0.14	1.13	0.18	0.46*	N/A	N/A	N/A
Average Precip. (in.)	0.00	0.00	0.04	0.00	0.15	0.01	0.04	0.01	0.06*	N/A	N/A	N/A

\* The data for the month of September is only available until the date when the report is signed.

## **1.4 Geology**

The Laredo Sheet (1976) of the Geologic Atlas of Texas published by the Bureau of Economic Geology of the University of Texas at Austin has mapped the Laredo Formation within the Eocene Period of Tertiary Geologic Age at the project location. The Laredo Formation generally consists of sandstone and clay; thick sandstone members in upper and lower part, very fine to fine grained, in part glauconitic, micaceous, ferruginous, cross bedded, dominantly red and brown; clay in middle, weathers orange-yellow; dark-gray limestone concretions common, some fossiliferous; marine mega fossils abundant. The thickness of this formation is about 620 feet.

## **2. FIELD AND LABORATORY TESTING**

### **2.1 Field Testing**

The project site was explored by drilling a total of five (5) soil test borings to depths varying from five (5) to twenty (20) feet in depth and within the proposed areas to receive the improvements. The field investigation included a reconnaissance of the project site, drilling of borings, performing standard penetration tests (SPT) and obtaining disturbed split-barrel samples, and auger samples. Soil samples were obtained at selected intervals in the soil test borings. Undisturbed soil samples were obtained in general accordance with ASTM D-1587 (Thin-Walled Tube Sampling of Soils) using a standard split-spoon sampler. A split-spoon sampler is a 2-inch O.D. tube that is driven into the soil to be sampled that can be split open lengthwise for easy removal and visual inspection of the soil obtained. Disturbed soil samples were obtained in general accordance with ASTM D-1586 (Penetration Test and Split-Barrel Sampling of Soils).

The results of the standard penetration test indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

### **2.2 Laboratory Testing**

Laboratory tests were carried out in a number of selected soil samples in order to acquire necessary soil engineering preparation with regards to the physical and mechanical properties of the soil layers and further on to evaluate and determine the parameters required for the engineering recommendations. Atterberg limits, moisture content and percent fines tests were performed to assist in classifying the soils and to provide indicators of soil strength and behavior. All phases of the laboratory-testing program were performed in general accordance with the applicable ASTM Specifications.

A summary of the laboratory test results is presented in the Appendix. The samples collected will be stored for 30 days from the date of issue of this report, and then disposed of unless otherwise instructed in writing by the client.



### 3. SITE AND SUBSURFACE CONDITIONS

#### 3.1 Site Conditions

The project site is within the existing Lake Casa Blanca International State Park, currently in use year round. During our field exploration operations, CET personnel observed and noted the following general site conditions:

- The proposed location for the Main Fire House and Administration Building is currently used as a Tennis Courts;
- The Tennis Courts parking exists at the east and north side of the Tennis Courts;
- The existing landscaping consists of trees and natural grass.

#### 3.2 Subsurface Conditions

The subsurface conditions encountered are shown in the boring logs found in the Appendix. The subsurface soil mixtures encountered, consists of clayey sand (SC), sandy lean clay (CL), fat sandy clay (CH), the soil mixtures encountered are competent soils for support of the proposed improvements. At various bore hole locations, hard cemented layers of the soil mixture were encountered, some as shallow as five (5) to six and a half (6 ½) feet below the surface and others at the lower depths drilled. The soils are underlain by any of the following: sandstone, siltstone, and various cemented sedimentary rock in most borings drilled. The results of our field exploration and laboratory testing indicate that the soil mixtures vary from non-expansive to low/moderate expansive potential.

**Table No. 4 - Major Strata**

Stratum	Location	Depth, feet*	Description and Classification
I	B1 B2 B3 B4	0 – 13 1/2 0 – 18 1/2 0 – 15 0 – 10	CLAYEY SAND (SC); brown, light brown, yellowish brown and light brownish gray, Inorganic clayey sand of low to moderate plasticity, firm to stiff to hard. Cemented after 5 feet in B2.
II	B1 B2	13 1/2 – 20 18 1/2 – 20	FAT CLAY (CH); grayish brown, yellowish brown and gray.
III	B4	0 – 5	SANDY CLAY (CL); brown.
IV	B5	0 – 5	CLAYEY GRAVEL (GC); light brown with sand.

\* The depths and thicknesses of the strata presented are based on information at the borehole locations and variations outside of the ranges of depth and thickness could occur between borehole locations.

The site soil has been evaluated by performing field and laboratory tests on the subsurface samples recovered during the drilling operations. The types of tests conducted on the subsurface samples are listed in the Appendix. The results of the tests are tabulated on the Logs of Borings, which are also provided in the Appendix. Field tests and the laboratory testing program were directed towards evaluating the shear strength, moisture content, volume change characteristics, and plasticity of the subsurface strata for this project. The Symbol Key and Unified Soil Classification System and Terms Sheets, which define the terms and descriptive symbols used on each boring log, are also presented in the Appendix.

### **3.3 Groundwater**

Groundwater was not encountered during the drilling operations. It is noted that groundwater levels will fluctuate with seasonal climatic variations; however, groundwater should not be a factor affecting design or construction at this site. Groundwater levels could be significantly higher after a major rainfall or in rainy season. *As such, the water table must be checked immediately prior to construction to assess its effect on dewatering and other construction activities.*

## **4. EVALUATION**

### **4.1 General**

All recommendations are based on knowledge of the area; however, the project design team should specify actual construction requirements. The final selection of foundation types and depths should be based on considerations of several factors, such as: 1) function of the structure, 2) soil strength properties, expansive properties, and settlement characteristics of subsurface materials; 3) the magnitude of applied structural loads; and 4) foundation construction costs.

### **4.2 Potential Vertical Rise (PVR)**

Potential vertical soil movements have been estimated using the Texas Department of Transportation method TEX-124-E, Potential Vertical Rise (PVR). This method utilizes the soils in-situ moisture conditions and plasticity characteristics within the active zone. It is estimated that depth of the active zone at this site is approximately 15 feet. *Based on the borings drilled at the site, our laboratory analyses indicate that the PVR at this site is **less than one (1) inch** in its present condition.* A sustained surcharge load of one (1) pound per square inch is assumed to be supplied by the floor and sustained live load in the PVR calculations. It is noted that the PVR estimates are provided as an indicator of the severity of potential soil movements at this site and are not intended as a prediction of actual soil foundation movements.

## **5. RECOMMENDATIONS**

### **5.1 Site Preparation**

The final grade elevation proposed for the proposed improvements was not provided to us; however, all final site grades must provide effective drainage that remains in conformance with existing drainage patterns during and after construction.

Site preparation should consist of the following:

1. Strip vegetation and loose topsoil, if any, containing significant organic material from the proposed construction area prior to build any foundation or installation of base material.
2. The exposed subgrade surfaces should then be proof rolled with a loaded heavy earthwork piece of machinery such as a motorized articulated scraper or dump truck to detect soft or loose zones, followed by proper soil replacement, as necessary to achieve the desired final grade elevations.
3. The subgrade should then be scarified to at least eight (8) inches; moisture conditioned between minus two (-2) to plus three (+3) percentage points of the optimum moisture and compacted to a minimum of 95 percent of the maximum dry density determined in accordance with ASTM D-698 (Standard Proctor).
4. Structural fill may consist of inorganic silty clays or sandy clays with a Liquid Limit (LL) of less than 35 and a Plasticity Index (PI) between seven (7) and fifteen (15). The fill should be placed in compacted lifts not to exceed six (6) inches in thickness, moisture conditioned between minus two (-2) to plus three (+3) percentage points of the optimum moisture and compacted to a minimum of 95 percent of the maximum dry density determined in accordance with ASTM D-698 (Standard Proctor).

*Particular attention should be given to maintaining the proper moisture content during compaction and to prevent the fill from drying before subsequent lifts are placed.*

## **5.2 IBC Considerations**

Chapter 18 of the International Building Code (IBC) provides additional requirements that impact the design of foundations. Section 1802 addresses foundations and soils investigations, sub-section 1802.3 addresses soil classification and specifically expansive soils (1802.3 & 1805.8). Highly expansive clay was not encountered; however the IBC should be consulted for the final foundation design.

## **5.3 Design Parameters**

### **Foundation Design Criteria**

Principal column and wall loads for the Webb County Main Fire Station and Administration Building structures may be supported on individual or continuous spread footings in combination with a structural fill slab-on-grade and be founded within the low plasticity clays at a minimum depth of at least thirty-six (36) inches below the existing ground surface, found at time of our drilling operations. The spread footings and slab beams may be designed with an end bearing pressure in combination with the associated skin friction values as depicted in the following paragraph. This bearing pressure is based on a factor of safety against bearing capacity failure of approximately three (3).

The proposed building foundation improvements may be founded on natural soils at the three to five (3 - 5) foot depths and be designed for a bearing pressure based on total loads per Table 5.

**Table No. 5 – Continuous Spread Footings**

<b>Spread or Continuous Footing</b>	<b>3' Depth</b>	<b>4' Depth</b>	<b>5' Depth</b>
2' Width	3000 psf/1ft	4600 psf/1ft	5500 psf/1ft

**Slab-on-fill supported foundation systems** may be utilized provided the building pad select fill and supporting subgrade is properly prepared and moisture conditioned. The stiffened beams should be founded a minimum of **36 inches below** finish floor grade and the foundation system be on a **supporting subgrade of 18 inches** of properly prepared, compacted, and moisture conditioned structural fill. The fill supported foundation may be designed for a bearing capacity of **3.0 kips per square foot (ksf)** based on total loads, , or a dead load plus long term live load net bearing pressure of **2,000 psf**, whichever results in a larger bearing surface.

When establishing final grade around the structures, we recommend the following:

1. Elevation of ground surface adjacent to the foundation should be a minimum of at least six (6) inches below finished floor.
2. The slope of the ground surface away from the structure should be a minimum of five (5) percent for a distance of at least ten (10) feet.
3. A two (2) feet wide mow band or a six (6) inches thick clay soil mat barrier around the foundation perimeter can also be installed to mitigate moisture changes affecting the foundation performance.

These recommendations are for proper development of bearing capacity for the continuous beam sections of the foundation system and to reduce the potential for water to migrate beneath the slab foundation. These recommendations are not based on structural considerations. Grade beam depths for both the exterior and interior grade beams may need to be greater than recommended herein for structural considerations and should be properly evaluated and designed by the structural engineer. The grade beams or slab portions may be thickened and widened to serve as spread footings at concentrated load areas.

CET has no detailed design information regarding the structured materials proposed; therefore, we still recommend that some interior beams be installed that meet the minimum requirements per an acceptable method for calculating structural loads, deflections and design stresses. Final foundation design considerations must be based on final structural considerations per the project structural engineer.

The footings can provide some uplift resistance for those structures subjected to wind or other induced structural loading. The uplift resistance of a spread footing may be computed using the effective weight of the soil above the spread footing along with the weight of the spread footing and structure. A soil unit weight of 100 pcf may be assumed for the select fill placed above the footing, provided that the select fill is properly compacted as

recommended in this report. If the footing foundations are over excavated and formed, the backfill around the foundation sides should be achieved with compacted select fill, lean concrete, compacted cement stabilized sand (two sacks cement to one cubic yard of sand) or flowable fill. The fill should be placed in compacted lifts not to exceed six (6) inches in thickness, moisture conditioned between minus two (-2) to plus three (+3) percentage points of the optimum moisture and compacted to a minimum of 95 percent of the maximum dry density determined in accordance with ASTM D-698 (Standard Proctor). Reinforcing steel should be placed and the foundation poured the same day of excavation.

For foundations designed and constructed in accordance with the recommendations in this report and under static loading conditions, total post-construction foundation settlement is expected to be less than about one (1) inch. Post-construction differential settlement is expected to be about half of the total settlement. Settlement of the footings can be reduced to the smallest amount compatible with the general method of construction. In general, the foundation will be considered satisfactory if it does not transmit pressures to the subsoil that exceed the safe load or that will cause excessive settlement.

#### 5.4 Lateral Analysis

Presented in the Table below are the recommended soil parameters, which may be used for the lateral load analysis.

**Table No. 6 – Lateral Load Soil Parameters**

Depth*, (ft)	Friction Angle** (deg)	Rankine Active Earth Pressure, K (a)	Rankine Passive Earth Pressure, K (p)
0 – 10	28	0.36	2.77

\* Based on existing surface at time of drilling operations

\*\*Estimated value

Passive Earth Pressure, K(p)	Depth	Equivalent Fluid Pressure
2 k/f	10 feet with respect to existing natural ground	40 psf

#### 5.5 Vapor Retarder Membrane/Vapor Barrier

Subsurface moisture and moisture vapor naturally migrate upward through the soil and, where the soil is covered by a building, this subsurface moisture will collect. To reduce the impact of this subsurface moisture and the potential impact of introduced moisture (such as landscape irrigation or plumbing leaks) the current industry standard is to place a vapor retarder membrane on the compacted granular layer. This membrane typically consists of polyvinyl plastic sheeting at least 10 mills in thickness. It should be noted that although capillary break and vapor barrier systems are currently the industry standard, this system may not be completely effective in preventing floor slab moisture problems. These systems will not "moisture proof" the mat/slab nor will it assure mat/slab moisture transmission rates

will meet floor-covering manufacturer standards. The design and construction of such systems are dependent on the proposed use and design of the proposed building and all elements of building design and function should be considered in the mat/slab foundation design. Building design and construction may have a greater role in perceived moisture problems or inadequate ventilation may result in excessive moisture in a building and affect indoor air quality.

The structural engineer is often faced with the decision to use a vapor barrier or a vapor retarder. ACI 302.1 has recently provided a flowchart to assist the designer in making this controversial decision. The structural designer must decide if the mat/slab will have a vapor sensitive floor treatment above or simple concrete finish to determine if the vapor barrier goes below the slab, the slab dry granular base, or perhaps no vapor barrier is required at all.

## **5.6 Flatwork**

For any flatwork outside of the building areas which will be sensitive to movement, subgrade preparation as discussed above should be strongly considered to reduce differential movements between the flatwork and the adjacent structure. If subgrade preparation as given above for structures is not implemented in the exterior flatwork areas, those areas may be susceptible to post construction movements. If these areas do heave, it could result in reversed grading with surface runoff and drainage flowing towards the structure.

## **5.7 Selection and Placement of Fill**

Select fill soils may be required to achieve the proposed site grades. All imported or on-site non expansive select fill soils should be nearly-free of organic or other deleterious debris, essentially non-plastic, and less than two and one-half (2 ½) inches in maximum dimension. Coarse-grained soils are preferred for fill; however, most fine-grained soils can be used advantageously if attention is given to drainage, compaction requirements, moisture and density control.

Well-graded mixtures of crushed stone, clayey gravel; caliche and small quantities of cobbles, rock fragments, and/or clayey soils are generally acceptable for use as select fill. The clayey gravel should meet the gradation criteria for Item 247, Type "B", Grades 1 through 3 as specified in the 2004 TxDOT Standard Specifications manual. The crushed stone should meet the gradation criteria for Item 247, Type "A", Grades 1 through 3 as specified in the 2004 TxDOT Standard Specifications manual. The fill material should meet the PI requirements presented in this section. *On-site soils should be clean of all debris and meet the requirements of select fill material presented in this report.*

The fill should be placed in compacted lifts not to exceed six (6) inches in thickness, moisture conditioned between minus two (-2) to plus three (+3) percentage points of the optimum moisture and compacted to a minimum of 95 percent of the maximum dry density determined in accordance with ASTM D-698 (Standard Proctor).

## **5.8 Utility Trench Excavation and Backfill**

It appears that excavation for utility trenches can be readily made with a conventional

excavator in either native soil or compacted imported fill. If trenches are extended deeper than five (5) feet or are allowed to dry out, the excavations may become unstable and should be evaluated to verify their stability prior to occupation by construction personnel. Shoring or sloping of any deep trench walls may be necessary to protect personnel and provide temporary stability. All excavations should comply with current OSHA safety requirements for soils (Federal Register 29 CFR, Part 1926).

During wet weather, runoff water should be prevented from entering excavations. Water should be collected and disposed of outside the construction and the construction limits. Heavy construction equipment, excavated soil, and vehicular traffic should not be allowed within a distance of at least one-third ( $\frac{1}{3}$ ) the slope height from the top of any excavation.

We recommend all backfill be placed in compacted lifts not to exceed six (6) inches in thickness, moisture conditioned between minus two (-2) to plus three (+3) percentage points of the optimum moisture and compacted to a minimum of 95 percent of the maximum dry density determined in accordance with ASTM D-698 (Standard Proctor). Jetting and flooding should not be permitted. Poor compaction in utility trench backfill may cause excessive settlements resulting in damage to the pavement structural section or other overlying improvements. Compaction of trench backfill outside of improvement areas should be a minimum of 90 percent relative compaction.

Another fast and economical backfill alternative is the use of flowable Controlled Low Strength Material (CLSM) mixtures due to the saving of labor and time over placing and compacting soil or granular materials. If it is anticipated or specified that the flowable lean-mix backfill may be excavated at some point in the future the strength must be much lower than the 1,200 psi which the American Concrete Institute (ACI) uses as the upper limit for CLSM. The late-age strength of removable CLSM materials should be in the range of 30 to 150 psi as measured by compressive strength in cylinders. Controlled Low Strength Material (CLSM) is defined in ACI 229R and TxDOT Item 401.

## **6. PAVEMENT DESIGN CRITERIA**

### **6.1 Pavement Structural Design**

The proposed pavement sections should be reviewed by the project design team in consultation with the owner during development of the final plans. The pavement thickness designs are shown in the Appendix and are summarized below.

**Table No. 7 – Flexible Pavement Design**

<b>Component</b>	<b>Thickness, in.</b>
HMAC, Type "C" or "D"	2.5
Flexible Base	12.0
Modified Subgrade or Geogrid	---



Moisture Conditioned Subgrade	8.0
-------------------------------	-----

**Table No. 8 - Rigid Pavement Design Alternatives, inches**

Component	Thickness, in.
Reinforced Concrete	7.0
Modified Subgrade	---
Moisture Conditioned Subgrade	8.0

## **6.2 Selection and Placement of Pavement Materials**

Presented below are selection and preparation guidelines for various materials that may be used to construct the pavement sections.

### **6.2.1 Hot Mix Asphaltic Concrete (HMAC)**

We recommend that the asphaltic concrete surface course should meet 2004 TxDOT Standard Specifications Item 341 and Item SS3224 (2011), Type "C" or "D" and its specific criteria for the Job Mix Formula (JMF). The Super Pave Gyratory, design number of revolutions ( $N_{des}$ ) for the asphaltic mix should be in accordance with TEX-241-F. The Performance Graded (PG) binders should be at least PG 64-22 for the light traffic, or should be at least PG 70-22 for the truck areas and high traffic volume. These binders provide 98 percent reliability against rutting and 98 percent reliability against low temperature thermal cracking to accommodate slow moving, to prevent rutting because of the turning movements and stop and go traffic.

The mix should be compacted to between 91 and 95 percent of the maximum theoretical density as measured by TEX-207-F and TEX-227-F. The asphalt cement content by percent of total mixture weight should fall within a tolerance of  $\pm 0.3$  percent asphalt cement from the specific mix. Aggregates known for stripping should not be used unless measures are taken to address this concern. Typically, this includes the use of an anti-strip agent. The mix should have at least 70 percent strength retention when tested in accordance with TEX 531-C.

### **6.2.2 Asphalt Stabilized Base or HMAC Type "A" or "B"**

The Asphalt Stabilized Base or HMAC Type "A" or "B" materials should meet the specification requirements of 2004 TxDOT Standard Specifications manual, Item 341 Type "A". Every two (2) inches of flexible base material may be replaced with one (1) inch of Asphalt Stabilized Base or HMAC Type "A" or "B".



### **6.2.3 Reinforced Concrete**

Reinforced concrete should have a minimum 28-day design compressive strength of 4,000 psi. The concrete should be properly cured in accordance with American Concrete Institute (ACI) recommended procedures and vehicular traffic should not be allowed for at least three (3) days (light traffic) or seven (7) days (heavy traffic).

### **6.2.4 Flexible Base**

Base material may be composed of crushed stone base meeting all of the requirements of 2004 TxDOT Standard Specifications manual Item 247, Type "A", Grades 1 or 2. As an alternate to the Type "A" base material, caliche (treated with lime or cement) should meet the requirements for Item 247, Type "B", Grades 1 through 3 as specified in the 2004 TxDOT Standard Specifications manual. *In addition the percent passing No. 200 sieve should not exceed 20 percent.*

The base should be compacted to at least 95 percent of the maximum dry density as determined by the modified moisture-density relationship (ASTM D-1557) at moisture contents ranging between minus two (-2) and plus three (+3) percentage points of the optimum moisture content

### **6.2.5 Moisture Conditioned Subgrade**

The subgrade should be scarified to a depth of at least eight (8) inches and moisture conditioned at moisture contents ranging between minus two (-2) to plus three (+3) percentage points of the optimum moisture content. The subgrade should then be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D-698. *The subgrade should be moisture conditioned just prior to fill placement in order that the subgrade maintains its compaction moisture levels and does not dry out.*

Pavement areas should be stripped of vegetation, debris and loose topsoil, and the exposed subgrade should be proof rolled with appropriate construction equipment weighing at least 15 tons. The purpose of this recommendation is to check the subgrade for weak or soft areas prior to fill placement and compaction. This operation should be observed and evaluated by qualified geotechnical personnel experienced in earthwork operations.

If weak or soft areas are evidenced during proof rolling operations, the soil in the subject area should be removed to expose competent subgrade soils in both horizontal and vertical limits. The excavated soils, provided they are not contaminated with deleterious materials, or clean imported fill soils can be used to restore grade at these isolated areas; any imported fill should meet the requirements for select fill. Placement and compaction of the soils should be as discussed below.

## **7. GENERAL REMARKS**

### **7.1 Construction Services**

We recommend that **Castle Engineering & Testing, LLC** be retained to provide construction materials testing services during grading and foundation construction activities. This is to observe compliance with the plans, specifications, and geotechnical

recommendations and to allow design changes if the subsurface conditions differ from those anticipated before construction.

## **7.2 Limitations**

The evaluation and recommendations submitted in this report are based, in part, upon the information obtained from the soil borings drilled. The nature and extent of variations in the soil conditions between or beyond the borings and excavations may not become evident until actual construction.

The transition lines shown on the boring logs are approximate and the actual transitions may be gradual. If changes in nature or design of the project are planned, the conclusions and recommendations in this report should be reviewed by the soils engineer and if necessary, modified. Soil samples not altered by laboratory testing will be retained for a period of 30 days and then, unless we are directed otherwise, will be discarded.

This report has been prepared for the exclusive use of **Hickey-Peña Architects, LLC** and their design team for specific application to the proposed **Webb County Main Fire Station and Administration Building** in Laredo, Webb County, Texas, according to accepted foundation-engineering practices. No other warranty, expressed or implied, is made.

## **APPENDIX**

Vicinity Map

Boring Location Plan

Boring Logs

The Symbol Key Sheet

Unified Soil Classification System and Terms Sheet

Field and Laboratory Testing Procedures



## PROJECT

**Webb County Main Fire Station**  
**Lake Casa Blanca International State Park**  
**LAREDO, TEXAS**

SHEET TITLE

### VICINITY MAP

Date  
09/08/2014  
Prepared for:  
Hickey-Peña Architects  
Project No.  
14G027  
Designed By:  
Jesse P. Rodriguez, P.E.





**PROJECT**

**Webb County Main Fire Station  
Lake Casa Blanca International State Park  
LAREDO, TEXAS**

**SHEET TITLE**

**BORE LOCATION**



Date  
09/08/2014  
Prepared for:  
Hickey-Peña Architects  
Project No.  
14G027  
Designed By:  
Jesse P. Rodriguez, P.E.


# LOG OF BORING B-1

SHEET 1 of 1

PROJECT: Webb County Main Fire Station  
LOCATION: Lake Casa Blanca International State Park  
CLIENT: Hickey-Peña Architects, LLC

PROJECT NUMBER: 14G027  
DATE(S) DRILLED: 9/5/14  
SURFACE ELEVATION: N/A

FIELD DATA		LABORATORY DATA										DRILLING METHOD(S): Dry augered from 0 to 20 feet.	
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT R: RQD %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ.FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	GROUNDWATER INFORMATION: Subsurface water was not encountered during or after completion of drilling operations.
					LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX						
					LL	PL	PI						
DESCRIPTION OF STRATUM													
	5	N = 7	15	27	15	12						41	-CLAYEY SAND (SC); brown
		N = 21	10										
		N = 44	14	32	19	13						43	-CLAYEY SAND (SC); yellowish brown
		N = 57	16										
	10	N = 45	21										
	15	N = 38	24	50	24	26						98	-SANDY FAT CLAY (CH); grayish brown
		N = ref/3"	21										
	20												Boring Terminated at 20 Feet
													REMARKS: The borehole was backfilled with cuttings upon completion of the drilling operations.






# LOG OF BORING B-2

SHEET 1 of 1

PROJECT: Webb County Main Fire Station  
LOCATION: Lake Casa Blanca International State Park  
CLIENT: Hickey-Peña Architects, LLC

PROJECT NUMBER: 14G027  
DATE(S) DRILLED: 9/5/14  
SURFACE ELEVATION: N/A

FIELD DATA		LABORATORY DATA										DRILLING METHOD(S): Dry augered from 0 to 20 feet.	
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT R: RQD %	MOISTURE CONTENT (%)	ATTEBERG LIMITS			DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ.FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	GROUNDWATER INFORMATION: Subsurface water was not encountered during or after completion of drilling operations.
					LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX						DESCRIPTION OF STRATUM
					LL	PL	PI						
	5	N = 77	6										-Gravel (Caliche); light brown
		N = 50/4"	4	28	19	9					39	-CLAYEY SAND with GRAVEL (SC); yellowish brown	
		N = ref/3"	7										
		N = ref/3"	9										
		N = 50/2"	11										
	10	N = 50/2"	14										
	20	N = 50/3"	17	49	22	27						96	-SANDY FAT CLAY (CH); grayish brown
													Boring Terminated at 20 Feet
													REMARKS: The borehole was backfilled with cuttings upon completion of the drilling operations.



**CASTLE**  
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LOG OF BORING - CASTLE.GDT - 9/22/14 11:08 - N:\GEOTECHNICAL\GINT\PROJECTS\14G027.GPJ




# LOG OF BORING B-3

SHEET 1 of 1

PROJECT: Webb County Main Fire Station  
LOCATION: Lake Casa Blanca International State Park  
CLIENT: Hickey-Peña Architects, LLC

PROJECT NUMBER: 14G027  
DATE(S) DRILLED: 9/5/14  
SURFACE ELEVATION: N/A

FIELD DATA		LABORATORY DATA										DRILLING METHOD(S): Dry augered from 0 to 15 feet.		
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT R: RQD %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ.FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	GROUNDWATER INFORMATION: Subsurface water was not encountered during or after completion of drilling operations.	
					LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX							
					LL	PL	PI							
DESCRIPTION OF STRATUM														
	5	N = 45	7											-Gravel (Caliche); light brown
		N = 32	7	31	18	13						37	-CLAYEY SAND (SC); brown	
		N = 33	6											
		N = 75/10"	8	30	18	12						41	-CLAYEY SAND (SC); yellowish brown	
		N = 50/3"	8											
	10													
		N = 50/2"	8											
	15													
													Boring Terminated at 15 Feet	
													REMARKS: The borehole was backfilled with cuttings upon completion of the drilling operations.	



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LOG OF BORING - CASTLE.GDT - 9/22/14 11:08 - N:\GEOTECHNICAL\GINT\PROJECTS\14G027.GPJ







# LOG OF BORING B-4

SHEET 1 of 1

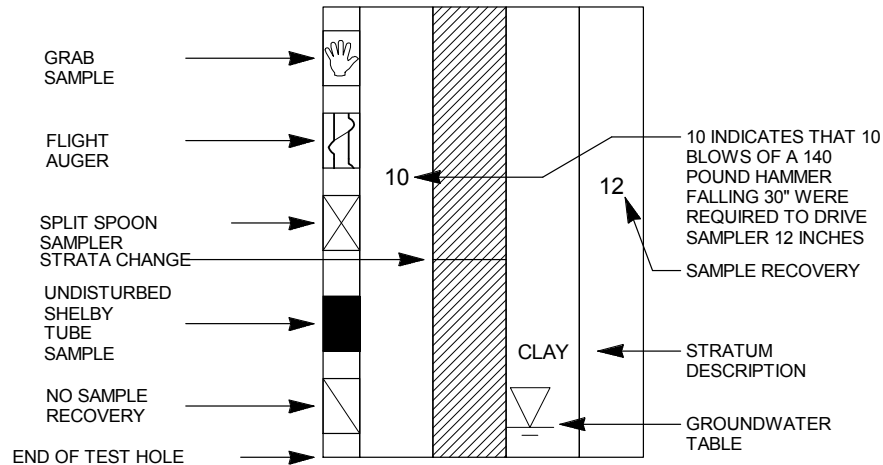
PROJECT: Webb County Main Fire Station  
LOCATION: Lake Casa Blanca International State Park  
CLIENT: Hickey-Peña Architects, LLC

PROJECT NUMBER: 14G027  
DATE(S) DRILLED: 9/5/14  
SURFACE ELEVATION: N/A

FIELD DATA		LABORATORY DATA								DRILLING METHOD(S): Dry augered from 0 to 5 feet.			
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT R: RQD %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	GROUNDWATER INFORMATION: Subsurface water was not encountered during or after completion of drilling operations.
					LL LIQUID LIMIT	PL PLASTIC LIMIT	PI PLASTICITY INDEX						
													DESCRIPTION OF STRATUM
	5		N = 54	6									
			N = 41	13	34	21	13						60
													Boring Terminated at 5 Feet
													<b>REMARKS:</b> The borehole was backfilled with cuttings upon completion of the drilling operations.



# SYMBOL KEY SHEET



## MATERIAL SYMBOLS

	FILL		TOPSOIL		PEAT (PT)		ORGANIC CLAY (OH)		ORGANIC SILT (OL)
	CLAY PLASTIC (CH)		CLAY (CL)		SILTY CLAY (CL-ML)		SILT PLASTIC (MH)		SILT (ML)
	SAND WELL GRADED (SW)		SAND POORLY GRADED (SP)		SAND CLAYEY (SC)		SAND SILTY (SM)		SAND (SW-SC)
	SAND (SW-SM)		SAND (SP-SC)		SAND (SP-SM)		SAND (SC-SM)		GRAVEL WELL GRADED (GW)
	GRAVEL POORLY GRADED (GP)		GRAVEL CLAYEY (GC)		GRAVEL SILTY (GM)		GRAVEL (GW-GC)		GRAVEL (GW-GM)
	GRAVEL (GP-GC)		GRAVEL (GP-GM)		LIME-STONE		SHALE		BASALT
	SAND-STONE		BEDROCK		ASPHALT		CONCRETE		BASE
	MARL		CLAYSTONE						

## STANDARD PENETRATION TEST (ASTM D 1586) DRIVING RECORD

Note: Driving is limited to 50 blows per interval, or 25 blows for 0.25 inch advancement, whichever controls. This is done to avoid damaging sampling tools

### Blows Per Foot

25  
50/4"  
ref/2"

### Description

Sampler was seated 6 inches, then 25 blows were required to advance the sampler 12 inches.  
Sampler was seated 6 inches, then 50 blows were required to advance the sampler 4 inches.  
Sampler could only be driven 2 inches of the 6 inch seating penetration before the 50 blow limit was reached.

## SAMPLER SYMBOLS

	FLIGHT AUGER		CORE BARREL		DISTURBED SAMPLE		NO RECOVERY		PISTON SAMPLER		SHELBY TUBE (3")		SPLIT BARREL (SPT)		GRAB SAMPLE
--	--------------	--	-------------	--	------------------	--	-------------	--	----------------	--	------------------	--	--------------------	--	-------------

Project Name: Webb County Main Fire Station and Administration Building Figure No. 1  
Project Number: 14G027

# UNIFIED SOIL CLASSIFICATION SYSTEM AND TERMS

## TERMS DESCRIBING CONSISTENCY OR CONDITION

**COARSE-GRAINED SOILS** (major portions retained on No. 200 sieve): includes (1) clean gravel and sands and (2) silty or clayey gravels and sands. Condition is rated according to relative density as determined by laboratory tests or standard penetration resistance tests.

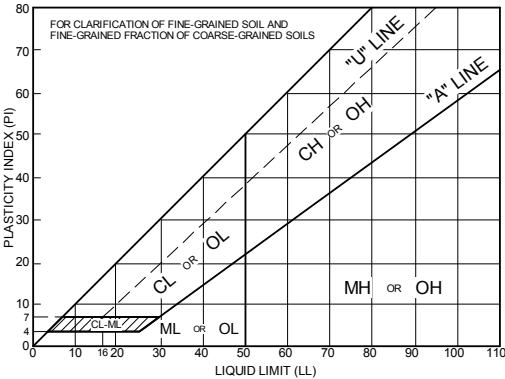
Descriptive Terms	Relative Density	SPT Blow Count
Very loose	0 to 15 %	< 4
Loose	15 to 35 %	4 to 10
Medium dense	35 to 65 %	10 to 30
Dense	65 to 85 %	30 to 50
Very dense	85 to 100 %	> 50

**FINE-GRAINED SOILS** (major portions passing on No. 200 sieve): includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings, SPT blow count, or unconfined compression tests.

Unconfined Compressive		
Descriptive Terms	Strength kPa	SPT Blow Count
Very soft	< 25	< 2
Soft	25 to 50	2 to 4
Medium stiff	50 to 100	4 to 8
Stiff	100 to 200	8 to 15
Very stiff	200 to 400	15 to 30
Hard	> 400	> 30

## GENERAL NOTES

- Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
- Surface elevations are based on topographic maps and estimated locations.
- Descriptions on these boring logs apply only at the specific boring locations and at the time the borings were made. They are not guaranteed to be representative of subsurface conditions at other locations or times.

Major Divisions		Group Symbols	Typical Names		Laboratory Classification Criteria		Particle Size		Material	
<div>Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)</div> <div>Gravels (More than half of coarse fraction is larger than No. 4 sieve size) Clean gravel (Little or no fines)</div> <div>GW</div> <div>Well-graded gravels, gravel-sand mixtures, little or no fines</div> <div>GP</div> <div>Poorly-graded gravels, gravel-sand mixtures, little or no fines</div> <div>GM*</div> <div>d u</div> <div>Silty gravels, gravel-sand-silt mixtures</div> <div>GC</div> <div>Clayey gravels, gravel-sand-silt mixtures</div> <div>Sands (More than half of coarse fraction is smaller than No. 4 sieve size) Clean sands (Little or no fines)</div> <div>SW</div> <div>Well-graded sands, gravelly sands, little or no fines</div> <div>SP</div> <div>Poorly-graded sands, gravelly sands, little or no fines</div> <div>SM*</div> <div>d u</div> <div>Silty sands, sand-silt mixtures</div> <div>SC</div> <div>Clayey sands, sand-clay mixtures</div> <div>Fire-Grained soils (More than half the material is smaller than No. 200 sieve size)</div> <div>Silts and Clays (Liquid limit less than 60)</div> <div>ML</div> <div>Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity</div> <div>CL</div> <div>Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays</div> <div>OL</div> <div>Organic silts and organic silty clays of low plasticity</div> <div>MH</div> <div>Inorganic silts, micaceous or disto-maceous fine sandy or silty soils, organic silts</div> <div>CH</div> <div>Inorganic clays of high plasticity, fat clays</div> <div>OH</div> <div>Organic clays of medium to high plasticity, organic silts</div> <div>Highly Organic Soils</div> <div>Pt</div> <div>Peat and other highly organic soils</div>					<div><math>C_u = \frac{D_{60}}{D_{10}}</math> greater than 4; <math>C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}</math> between 1 and 3</div> <div>Not meeting all gradation requirements for GW</div> <div>Atterberg limits below "A" line or P.I. less than 4</div> <div>Atterberg limits above "A" line or P.I. greater than 7</div> <div><math>C_u = \frac{D_{60}}{D_{10}}</math> greater than 6; <math>C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}</math> between 1 and 3</div> <div>Not meeting all gradation requirements for SW</div> <div>Atterberg limits below "A" line or P.I. less than 4</div> <div>Atterberg limits above "A" line or P.I. greater than 7</div> <div>Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols</div> <div>Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols</div>		mm < 0.074		mm Sieve sizes < #200 #200 to #40 #40 to #10 #10 to #4	
					<div>Determine percentages of sand and gravel from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve) coarse-grained soils are classified as follows:</div> <div>Less than 5 percent..... GW, GP, SW, SP More than 12 percent..... GM, GC, SM, SC 6 to 12 percent..... Borderline cases requiring dual symbols**</div>		mm < 0.074		mm Sieve sizes < #200 #200 to #40 #40 to #10 #10 to #4	
					<div>Plasticity Chart</div> 		mm Sieve		mm Sieve	
							mm Sieve		mm Sieve	
							mm Sieve		mm Sieve	
							mm Sieve		mm Sieve	
							mm Sieve		mm Sieve	
							mm Sieve		mm Sieve	
							mm Sieve		mm Sieve	
							mm Sieve		mm Sieve	
							mm Sieve		mm Sieve	
							mm Sieve		mm Sieve	

\* Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg Limits: suffix d used when L.L. is 23 or less and the P.I. is 6 or less; the suffix u is used when L.L. is greater than 26.

\*\* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Project Name: Webb County Main Fire Station and Administration Building  
Project Number: 14G027

## FIELD AND LABORATORY TESTING PROCEDURES



### FIELD TESTING

#### A. Boring Procedure Between Samples

The borehole is extended downward, between samples by continuous flight, hollow or stem augers or by rotary drilling techniques using bentonite drilling fluid or water.

#### B. Penetration Test and Split-Barrel Sampling of Soils (ASTM D-1586)

This sampling method consists of driving a 2-inch outside diameter split barrel sampler using a 140 pound hammer freely falling through a distance of 30 inches. The sampler is first seated 6 inches into the material to be sampled and then driven an additional 12 inches. The number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance. Recovered samples are first classified as to color and texture by the field logger. Later, in the laboratory, the field logger's classification is reviewed by the soils engineer who examines each sample.

#### C. Thin-Walled Tube Geotechnical Sampling of Soils (ASTM D-1587)

This method consists of pushing thin walled steel tubes, usually 3 inches in diameter, into the soils to be sampled using hydraulic or other means. Cohesive soils are usually to be sampled in this manner and relatively undisturbed samples are recovered.

#### D. Soil Investigation and Sampling by Auger Borings (ASTM D-1452)

This method consists of augering a hole and removing representative soil samples from the auger flight or bit at 5 foot intervals or with each change in the substrata. Disturbed samples are obtained and this method is, therefore, limited to situations where it is satisfactory to determine the approximate subsurface profile.

#### E. Diamond Core Drilling for Site Investigation (ASTM D-2113)

This method consists of advancing a hole into hard strata by rotating a single or double tube core barrel equipped with a cutting bit. Diamond, tungsten carbide, or other cutting agents may be used for the bit. Wash water is used to remove the cuttings and to cool the bit. Normally, a 2 inch outside diameter by 1½ inch inside diameter (NX) coring bit is used unless otherwise noted. The rock or hard material recovered within the core barrel is examined in the field and in the laboratory and the cores are stored in partitioned boxes. The core recovery is the length of the material recovered and is expressed as a percentage of the total distance penetrated.

#### F. Visual – Manual Soil Classification Procedure (ASTM D-2488)

This procedure is a visual – manual soil classification methodology for the description of soil for engineering purposes when precise soil classification is not required.

### LABORATORY TESTING

#### A. Atterberg Limits: Liquid Limit (LL), Plastic Limit (PL) and Plasticity Index (PI) of Soils (ASTM D-4318 or TEX 104-E, 105-E and 106-E)

Atterberg Limits determine the soil's plasticity characteristics. The soil's Plasticity Index (PI) is representative of this characteristic and is the difference between the Liquid Limit (LL) and the Plastic Limit (PL). The LL is the moisture content at which the soil will flow as a heavy viscous fluid. The PL is the moisture content at which the soil begins to lose its plasticity. The test results are presented on the boring logs adjacent to the appropriate sampling information.

#### B. Particle Size Analysis of Soils (ASTM D-422 or TEX 110-E)

Grain size analysis tests are performed to determine the particle size and distribution of the samples tested. The grain size distribution of the soils coarser than the Standard No. 200 sieve was determined by passing the sample through a standard set of nested sieves.

#### C. Laboratory Determination of Water (Moisture) Content of Soil and Rock (ASTM D-2216 or TEX 103-E)

The moisture content of soil is defined as the ratio, expressed as a percentage, of the weight of water in a given soil mass to the weight of solid particles. It is determined by measuring the wet and oven dry weights of a soil sample. The test results are presented on the boring logs.

#### D. Unconfined Compressive Strength of Cohesive Soil (ASTM D-2166)

The unconfined compressive strength of soil is determined by placing a section of an undisturbed sample into a loading frame and applying an axial load until the sample fails in shear. The test results are presented on the boring logs adjacent to the appropriate sampling information.

#### E. California Bearing Ratio (CBR) of Lab Compacted Soils (ASTM D-1883)

The CBR test is performed by compacting soil in a six inch diameter mold at the desired density, soaking the sample for four days under a surcharge load approximating the pavement weight and then testing the soils in punching shear. A two inch diameter piston is forced into the soil to determine the resistance to penetration. The CBR is the ratio if the actual load required to produce 0.1 inches of penetration to that producing the same penetration in a standard crushed stone.

#### F. Swell Test (ASTM D-4546)

The swell test is performed by confining a one inch thick specimen in a 2½ diameter stainless steel ring and loading the specimen to the approximate overburden pressure. The test specimen is then inundated with distilled water and allowed to swell for 48 hours. The volumetric swell is measured as a percentage of the total volume and is converted mathematically to linear swell.

#### G. Compaction Tests (ASTM D-698, D-1557, TEX 113-E and TEX 114-E)

The compaction test is performed by compacting soil in a steel mold at varying moisture contents. Layers are compacted using a hammer weight and number of blows per layer which vary with the different test procedures, ASTM D-698, D-1557, TEX 113-E and TEX 114-E. The data is plotted and the maximum unit weight and moisture content determined. The test results are given in the appendix with a notation of the test method used.

#### H. Classification of Soils for Engineering Purposes (Unified Soil Classification System, ASTM D-2487)

This standard describes a system for classifying mineral and organic-mineral soils for engineering purposes based on laboratory determination of particle size characteristics, liquid limit, and plasticity index shall be used when precise classification is required.

#### I. Amount of Material in Soils Finer Than the No. 200 (75µm) Sieve (ASTM D-1140)

There are two tests methods to cover determination of the amount of material finer than the No. 200 (75 µm) sieve by washing. Method A – Test specimen is not dispersed prior to wash sieving. Method B – Test specimen is dispersed by soaking in water containing a deflocculating agent prior to wash sieving.